5-1967

Irrigation Water Values in Cache County, Utah

Marlyn Fife

IRRIGATION WATER VALUES IN CACHE COUNTY, UTAH

by

Marlyn Fife

A thesis submitted in partial fulfillment
of the requirements for the degree

of

MASTER OF SCIENCE

in

Agricultural Economics

UTAH STATE UNIVERSITY
Logan, Utah

1967

ACKNOWLEDGMENTS

I should like to express my sincere appreciation to Dr. Gardner and other members of my committee for timely suggestions and the secretarial staff for assistance in preparing this thesis, and to the Department of Agricultural Economics for providing facilities and funds to make this study possible.

Last, but not least, I thank my wife for encouragement and for the many hours she has spent in typing rough drafts.

Marlyn Fife

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

LIST OF TABLES

LIST OF TABLES (continued)

LIST OF FIGURES

ABSTRACT

Irrigation Water Values in Cache County, Utah

by

Marlyn Fife, Master of Science

Utah State University, 1967

Major Professor: Dr. B. Delworth Gardner
Department: Agricultural Economics

In Utah all water, both on or below the ground surface, is considered public property. The right to use water is obtained by following certain subsidizing procedures of appropriation through the office of the State Engineer. Any right to the use of water may be changed to some other beneficial use with the approval of the State Engineer; however, there must be no interference with other rights, unless proper compensation has been made.

Agriculture still uses most of the available water in Utah; however, farmers' needs for water are not exactly the same. When allocation per acre is the same among farmers, water soon comes to have different values. Unless some mechanism arises to permit transfer of water, misallocation results. The Cache Valley area was chosen to illustrate the misallocation problem.

Input-output data which the Bureau of Reclamation used in their feasibility report on the Cache County area of the Oneida project were analyzed to determine the value of residual water. All factors of production except water, such as land, capital, seed, fertilizer, fuel, labor, and repairs were calculated at their market prices. These were

subtracted from the value of a unit of product and the residual value was then imputed to water as one estimate of its value. Varying farm sizes and different cropping practices were studied to show the effect these variables had on water values.

Agricultural water users on the Logan River distribution system were interviewed to find the value of water rentals and water-right sales. The water-right prices quoted by farmers and irrigation company officials were stated in terms of dollars per share. Since a share delivers varying quantities of water along the complete river system the "right" values were converted to value per acre-foot. Local customs, existing water laws and past court decisions were examined to ascertain their role in water transfer.

The principle of equal marginal value was applied to Logan River water supplies. Marginal value in use reflects the amount in dollars which consumers would be willing to pay for the last unit of water consumed. In a perfectly competitive rental market the price of water reflects the value of the marginal product.

A brief historical sketch of the Bear Lake system and the irrigation companies making up the Logan River distribution system is given. The water rights of the individual companies are listed and a brief resumé of water-right laws and administration is supplied. Legal decrees and litigations relative to irrigation supplies, power requirements and urban use, viz. the Call and Kimball and Logan City vs Water Users (1963) decrees are discussed. The effect these decisions have on water use in Cache Valley is noted.

(98 pages)

INTRODUCTION

Water is a unique and renewable resource, even after consumption. Apparently little if any water has escaped from the planet over the years. The natural cycle of evaporation and precipitation returns the water to the land, year after year. Water that has been absorbed by plants is transpired into the air; water that has wasted into the sea is evaporated. The airborne moisture returns to the land, mostly as rain or snow, in the never-ending cycle which allows man to survive on the face of the earth.

Other resources, such as petroleum, natural gas, and metals and minerals are not renewable; once consumed they are gone forever (5).

Man has always required water, but the world-wide problem of adequate supplies, as we are becoming increasingly aware of it today, is of comparatively recent origin. So long as water was easily accessible and abundant, man gave it no more thought than the air he breathed. He saw it as something vital to life, but something always present and therefore taken for granted.

In recent years, however, much public concern has developed, as consumption and pollution of current supplies has increased. Municipal government officials, interested scientists, and industrial and agricultural administrators have voiced their concern. This concern has stimulated much research by administrators, lawyers, engineers, and economists which ranges from developing and acquiring additional water supplies, preventing and lessening pollution, to the economics of water allocation.

Most of the settlers in America came from the humid countries of western Europe, where there was seldom a shortage of water. These people brought with them an old English common law concept known as the "theory of riparian rights." This theory, in substance, holds that a man owning land on the bank of a stream is entitled to have the water flow by his property unpolluted in quality and undiminished in quantity for all time by virtue of his ownership of the land along the stream (18, p. 232). Whether or not a man made use of the water that flowed by or through his land, his rights in it were not affected. In fact, the theory of riparian rights makes no provision for consumptive use of water beyond the small amount needed to water livestock and for domestic uses. The important thing, in the early days of the United States, was to maintain rivers and streams in their natural state for purposes of transportation and powering water wheels.

As the Nation grew and the population moved westward, less humid climates were encountered. These different conditions resulted in the development of a new concept of water rights. The farther west and south that they moved, the more arid the climate became. Rainfall was inadequate to grow crops or to furnish sufficient water to meet many of the normal human and animal needs. It therefore became necessary to utilize the streams and lakes to survive.

The Spaniards of Southern California had already realized the beneficial effects of irrigation but still held to riparian rights. When the Mormon pioneers entered the valley of the Great Salt Lake in July 1847, they stopped their wagons on the bank of City Creek and from it diverted a stream of water to flood an area of parched, sun-baked land to soften it enough to plough and plant their crops. In

so doing, they established a new custom among Anglo-Saxon people which was to become the basic water law of the west. This western water law is based on the consumptive use of water and works on the principle of "first in time is first in right, and beneficial use is the basis and the measure of the right" (3b) (73-1-1, 73-1-3). In other words, the man who first put water to beneficial use established his right and title to it, title that would not pass from him until he failed to beneficially use the water.

At the present time, the water law of the continental United States divides along the hundredth meridian, a natural climatic border of the Nation. The 31 Eastern States have retained the concept of riparian rights, and the 17 Western States have adopted the principle of "prior beneficial use," known as the doctrine of appropriation, either in direct or modified form, as the basis of their water laws (5). Under the doctrine of appropriation, water can be transferred from one land parcel to another or even one use to another as long as it doesn't impinge on another person's rights (18, p. 242).

By law, all water in the state of Utah, both on or below the ground surface, is considered public property. The right to use water is obtained by following certain specified procedures of appropriation through the office of the Utah State Engineer.

Any right to the use of water may be changed to some other beneficial use, with the approval of the state engineer. However, there must be no interference with other rights unless proper compensation is made. In the process of acquiring the right to use water in Cache Valley, settlers dug a proportion of the canal in accordance with the number of acres they owned under the canal. Individual rights for water use has not

come into importance until the last 60 years, when the state engineer made it compulsory to establish rights. These rights were tested in the early 1920's when legal problems arose with water rights.

Farmers' needs for water are not exactly the same. When allocation per acre is the same among farmers, water soon comes to have different values. Unless some mechanism arises to permit transfer of water, misallocation results. Since inter-company transfers have been few, it is important to know what legal and administrative restrictions have caused this apparent misallocation of irrigation water. Ways must be found to circumvent this problem and assure that future decisions may provide the legal and economic framework to meet future water needs.

JUSTIFICATION FOR RESEARCH

In the United States and especially in the arid west where water is not abundant, it becomes increasingly important that national and state agencies know more about the value of water in all uses. As agriculture is the largest user of water, it is especially vital that water value productivities be known so better allocation can be effected.

To make wise future decisions, organizations such as the State Water and Power Board, the Office of State Engineer, the State Legislature, the courts, and farmers must have knowledge as to the value of water and the needs for water in various areas of the State.

Objectives

The objectives of this study are to determine water values in Cache County, Utah, by two procedures: viz, (a) an economic efficiency evaluation of water allocation decrees and any impediments to transfer, and (b) the water rental markets and by the method of residual rents.

SOURCE OF DATA

The input-output data which the Bureau of Reclamation used in their feasibility report on the Cache County area of the Oneida Project were analyzed to determine the water values by the imputation approach. All factors of production except water, such as land, capital, seed, fertilizer, fuel, labor, and repairs were assumed to be worth their market prices in the productive process. These were subtracted from the value of a unit of product and the residual value was then imputed to water as one estimate of water value. Varying farm sizes and different cropping practices were studied to show what effect these variables had on water values.

Water users on the Logan River distribution system were interviewed to determine the value of water rentals and water-right sales. The water right prices quoted by farmers and irrigation company officials were stated in terms of dollars per share. Since a share delivers varying quantities of water along a complete river system, a conversion had to be made to "right" value per acre-foot. Since most of the water delivered is on an annual stream flow basis, and this varies, an average was used to reflect deliveries per share.

Local customs and existing water laws were examined to ascertain their role in water transfer. Water transfer information was obtained from farmers, watermasters, and presidents and secretaries of water companies. Minute books and various histories were also examined for historical background.

REVIEW OF LITERATURE

There is a voluminous amount of literature in the water resource area. To keep with the objectives of this study, the literature review was limited to water values and water market areas.

Hirshleifer, DeHaven, and Milliman have contributed a great amount to the literature of water allocation. Most of the attention in the past has been devoted by other authors to the acquisition of new water supplies and not much has been written about the question of whether existing supplies are being well utilized.

Following Hirshleifer et al., in utilizing existing water supplies, the following reasons make it sometimes difficult to define just what our limited supply is to do: (a) Annual and seasonal fluctuation in quantities available to our Nation and to any particular locality make planning more difficult. (b) It is difficult to know how great our underground supply is and how fast we can use it. (c) Water is not a perfectly interchangeable commodity because of its locality, seasonality and equality. (d) Water falling in the form of rain or underground water which benefits plants without human diversion is not included in our supplies. (e) Water which is reused may be counted twice as it successively serves several human purposes (power plants, fishing, boating, swimming, etc.) before being consumed (18, p. 23).

As industry and municipalities are expanding the use of water, there is increasing competition for existing supplies. The haphazard growth of water allocation systems has created major departures from a satisfactory pattern of water distribution. While a great deal has been written about the development of new supplies, not very much

effort has been devoted to investigating the competition between agriculture and municipalities for existing supplies (18, p. 32).

One of the major considerations impeding the efficient allocation of water resources is undoubtedly the imperfection of property water rights--most conspicuously, the limited transferability of water rights. There are many third party effects. One example is the Owens Valley water which was purchased by the city of Los Angeles. The farmers who didn't sell to the city were forced to bear the increased share of maintaining existing facilities and farm-related business suffered losses because of declining economic activity in the valley. Problems of this nature are often shifted from the market place to politicians and administrators (18, pp. 48-52).

Economic principles which apply in other areas of our economy also can apply to the allocation of our water supply. There are two methods by which decision making can take place. One is by "centralized planning," which coordinates requests for water through an ultimate authority. At the other extreme, the decision of the private individuals or firms may be coordinated through the supply and demand of an unregulated market (18, pp. 61-62, 222).

Hirshleifer *et al.* feel that a coordinated effort of both centralized planning and private firms and the use of economic principles would provide the most effective answer for many cases. They argue that transfer restrictions and failure to develop an adequate property rights structure for water supplies by using a pricing system are important obstacles to the efficient use of water resources (18, pp. 61, 225).

Hirshleifer *et al.* think that decisions about employment of our economic resources should be made predominantly by private individuals

and firms interacting through the market mechanism. The price system allocates resources among ends and uses when individuals have freedom to bargain to their best advantage. Such a system allows more efficient resource use (18, p. 223).

In 1962, Gardner described the problems of misallocation of grazing public range. He showed that public grazing was underpriced in comparison with prices charged by private ranchers for the same amount of feed. This was partially capitalized into the value of grazing permits. If permits were freely transferable, the difference between the value of the forage and the administered price plus the additional costs of using the public range would be capitalized into permit values. If permit values were in fact lower than this capitalized differential, then there is evidence of misallocation due to transfer impediments (12).

Because of transfer restrictions, permits are not transferable to ranches and ranchers where they would have maximum value. The same basic criteria can be used to show inefficiencies in the immobility of water rights.

Herbert H. Fullerton's Master's thesis on "Transfer and Misallocation of Irrigation Water" proved a valuable source of information about water allocation of four major irrigation companies in the Delta, Utah area. The primary object of this study was to show what happens when transfer flexibility is increased by permitting inter-company transfers of water from a situation where only intra-company transfers were permitted previously. The rental prices were compared when transfers were made between companies and between individuals within companies. Restrictive influences were studied as they affected the optimum allocation of irrigation water. He found that company policies which permitted free

transfer of water between companies produced a higher marginal product (rental price) than those which were only permitted intra-company transfers. The average rental price was significantly higher under free transfer policy. The higher the marginal product of water under similar or comparable physical and economic conditions, the greater the allocative efficiency, ceteris paribus (11, p. 103).

A study was made by T. Lynn Stewart of the Logan Pasture Water Company where 43 stockholder farmers irrigated 2,595 acres of land. Questionnaires completed by farmers were tabulated and the net value of irrigation water was figured, subtracting value of land without water, to be $3.71 per acre-foot in that area (30).

Hartman and Whittelsey made a study in Colorado by using linear programming to estimate various incremental or marginal values of water. The factors of land productivity, water use efficiency, timing and number and kind of enterprises which comprise the value of irrigation water were considered and their effect estimated within different assumptions about labor supply. Water values varied from 39 cents to $11.00 per acre-foot. As water supply increased from 2.18 to 3.63 acre-feet per acre, the average value dropped from $18.17 to $8.99. Hartman felt the need for a free water market to better allocate water among users (15).

METHOD OF PROCEDURE

Theoretical Model

The principle of equimarginal value in use will be applied to Logan River water supplies. "Marginal value in use" reflects the amount in dollars which consumers would be willing to pay for the last unit of water consumed. Value in use ordinarily declines as water consumption increases. Efficient allocation of water will be attained when no exchanges can be made which will be mutually advantageous to both parties. This would mean that both parties would value the last unit of water equally.

To illustrate the role of resource prices in allocating irrigation water among different farms, suppose that two farmers X and Y use resource A (water). We assume initially that units of A are "correctly" allocated among the two farmers. The value of the marginal product of A in farm X (V of MP_{ax}) is equal to the value of marginal product of A in farm Y (V of MP_{ay}). Assuming further that neither a surplus nor a shortage of A exists, then

$$V \text{ of } MP_{ax} = V \text{ of } MP_{ay} = P_a$$

where

P_a = price per acre-foot of A.

In a perfectly competitive rental market the price of water P_a would reflect the value of the marginal product.

Euler's Theorem and Residual Imputation

Under conditions of constant average cost and perfect competition Euler's Theorem states that if each factor is imputed its marginal product, the total product will be exhausted. This means that the total physical or value product can be distributed to the factors by which they are produced so as to exhaust the total amount of the total value of output (17, p. 408). This can be a very helpful tool to value water as Gardner states: "If all factors except water can be costed, the difference between the total revenue earned by selling the product and the cost of all the factors used excepting water will be the value imputed to water" (11, p. 7).

If the assumptions of constant average costs and perfect competition were to hold, small farms and large farms would exist side by side. There would be no economies or diseconomies of scale. Each farm would be able to buy unlimited amounts of inputs at the same price.

Efficiency Evaluation of Water Allocation

To show economic efficiency of water allocation, water values must be equal over and above third-party effects. If these values differ greatly among canals and water is not being transferred between the canals, then this means that for some reason transfers are not being made. Third-party effects could be more beneficial if downstream users were to transfer water to upstream users because the water would flow underground back into the river system for the lower canals.

If allocation decrees distribute water equally according to number of acres on the canal, all areas would have the same water supply (4).

If it can be shown that water requirements of agriculture on various canals are different by virtue of location, soil type, or for any other reason, then unless there are some transfers to accommodate these differences, this is a priori evidence of misallocation.

If there is evidence of transfer of water between users within irrigation companies where no impediments exist whatsoever it would suggest a priori that transfers might occur everywhere along the system if there were no impediments.

HISTORICAL BACKGROUND

Bear River System

The main reasons that Mormon pioneers were sent to settle Cache Valley were abundant water supply, ample forage for grazing, and tillable land. The principal source of water for the northern part of the valley is Bear River which heads in Summit County, Utah, and winds 500 miles through parts of Wyoming and southern Idaho, and enters northern Utah through the southwestern part of Cache Valley. It enters Box Elder County at Cutler Dam, meanders down through the Bear River Valley and eventually empties into the Great Salt Lake just west of Brigham City, Utah. It drains approximately 6,000 square miles and has more than 100 tributaries (28, p. 247).

With all its volume of water, Bear River presented problems to the early settlers. The river is slow moving and meanders along the bottom of the valley. A dam had to be built to divert water for irrigation. It wasn't until the turn of the century that the people were able to divert water from the river to irrigate the northern portion of Cache Valley. Since that time, it has been the most dependable source of water throughout the growing season. With the storage capacity of Bear Lake, it has become even more reliable.

The major streams used for irrigation and which drain the southern portion of the valley are Little Bear, Blacksmith Fork, Logan, and Summit Creek and Cub River running from south to north.

The early settlers of Wellsville started irrigation by diverting water from the Little Bear River through the East Field Canal to irrigate a total of 1,400 acres. The Logan and Hyde Park Canal on the Logan River was started in 1860. In that same year, water was brought from Blacksmith Fork to Millville, and Paradise used water from Little Bear to form the East Fork Canal. Later on, about 1880, the Cub River provided water for the Lewiston area. The large stream flow of these rivers provides a nearly adequate water supply during normal years.

The early settlers built their houses in "fort-style" settlements for protection against Indian attack. Their farms were in the lower valley floor until higher canals were constructed. Virtually all of the easily irrigated part of the valley was placed under canals and ditches by 1870.

Land distribution in the original settlement was under jurisdiction of Mormon ecclesiastical authorities. Each man was allowed as much land as he could conveniently operate; usually 20 acre tracts were apportioned by drawing lots. This was done in the Logan, Hyde Park, Mendon and Paradise areas. By 1900, there were 118 separate cooperative canal systems in the valley. Most of these projects were never incorporated and still remain as mutual companies managed by and belonging to the farmers they serve (28).

Virtually all of the farm land is privately owned. Water rights are owned and distributed, as of 1956, by 59 mutual irrigation companies organized by the farmers using the water. There are no "commercial" irrigation companies (a company which sells water for profit and handles it as a business) in the valley.

Logan River Distribution System

The Logan River Distribution System as shown in Figure 1 is composed of 20 different irrigation companies ranging in size from just a few irrigators who put water on city lots to the Logan Northern Canal which provides irrigation water for 3,700 acres. The Logan River System irrigates approximately 16,000 acres. Most early water users acquired rights to use water by participation in digging the canals. Each was responsible for the proportion of canal as corresponded to the number of acres which he intended to irrigate.

The Logan, Hyde Park, and Smithfield Irrigation Company

After the bottom lands were brought under cultivation, the settlers realized that the upland soils were rich if they could just be irrigated. Construction of a canal on the northern side of Logan Canyon was begun in 1882. By May 1883, water had been brought as far as North Logan, but because of several washouts along the canyon, the farmers were unable to successfully irrigate their crops that season (14, p. 117). The canal now has 101 headgates with 3,600 acres under irrigation.

The canal has two priority rights, one dated 1860 with a flow of 103.2 second-foot maximum flow and one which they filed on in 1928 with 21 second feet as shown in Table 1. In the summer and late season when Logan River water is divided as set out in the Kimball Decree of 1922, it is given less water because the latter right is cut out when water is in short supply.

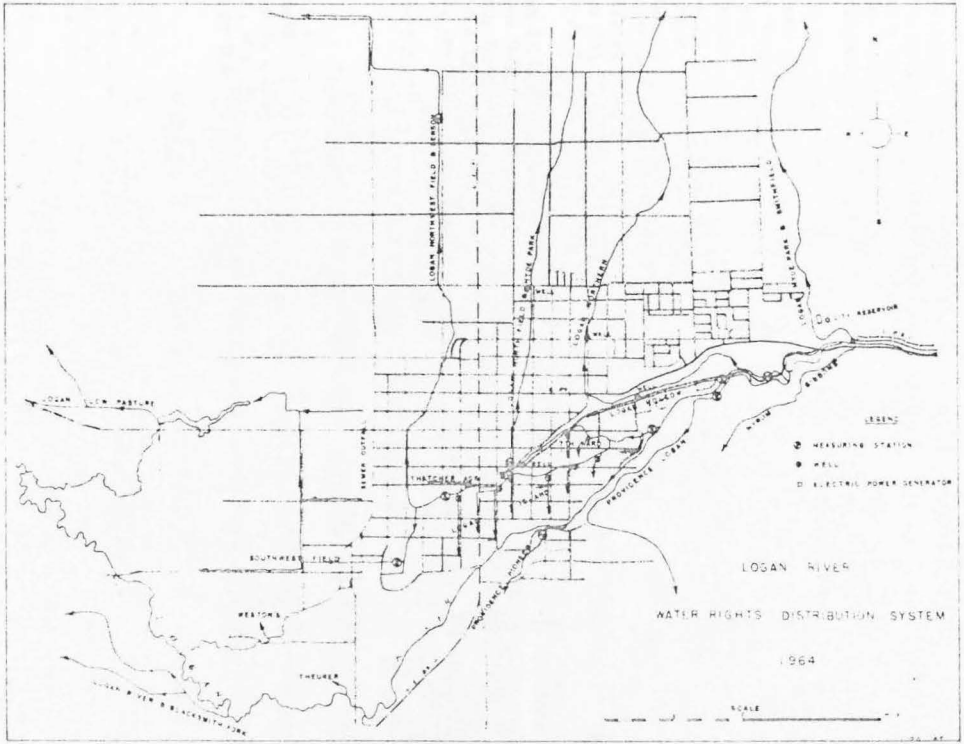

Figure 1. Logan River distribution system, Cache County, Utah Source: (2, 1961)

Table 1. Rights of record with priorities and flow right on Logan River, Cache County

Appropriator	Record	Priority	Maximum flow in second feet
Logan City Corp.	Decree	1859	10.0
Logan, Hyde Park & Sm.	Decree	1860	103.2
Logan & Northern	Decree	1860	103.2
Logan Hollow	Decree	1860	2.5
Providence--Logan	Decree	1860	14.7
Logan Island	Decree	1860	21.2
Seventh Ward Irr.	Decree	1860	2.0
Hyde Park & Logan North Field	Decree	1860	45.4
Thatcher	Decree	1860	0.8
Logan NW Field & Benson	Decree	1860	48.0
Southwest Field	Decree	1860	11.0
Providence Pioneer	Decree	1860	6.0
Southwest Field	Decree	1865	1.0
Logan Cow Pasture	Decree	1888	9.0
Ezra J. Nixon	Decree	1895	1.0
Hyrum Gibbons	Decree	1900	4.0
Eugene Schaub	Certificate	1906	2.0
Logan, Hyde Park & Sm.	Certificate	1928	21.0
Logan & Northern	Certificate	1928	10.0
U. S. Forest Service	Application	1937	10.0
Hyrum Gibbons	Application 32654	1963	2,000 ac.ft.
The following rights are usually filled by return flow			
Logan River & Blacksmith Fork	Decree	1877	34.0
Isaac P. Stewart	Decree	1919	0.5
H. E. Weston & Sons	Application	1953	2.0
T. Ray Theurer, et.al.	Certificate	1955	3.0
The following are non-consumptive use rights			
Central Milling Co.	Decree	1860	71.0
Utah Power & Light	Decree	1893	100.0
Utah Power & Light	Decree	1900	100.0
Utah State University	Decree	1908	150.0
Logan City	Book "A" of water claims in office of Co. Recorder	1903	300.0
Crowther Bros.	?	1956	59.0
Utah Power & Light	Application	1921	125.0

Source: [2, 1964, Appendix 5(6)]

The Providence Canal

This is the only canal of any size that diverts water from the south or the left bank of the Logan River. It was begun in 1866, but company engineers set pegs on an ascending grade from the River. Since the water could not be induced to flow uphill, the enterprise was abandoned until 1883 when the necessary changes in the elevation were made and the canal was completed. The cost of maintenance has always been high because of its faulty location. The canal irrigates 400 acres, mostly in city lots, in the River Heights area (Figure 1).

The Logan, North Field, and Hyde Park Canal

This canal was begun in the spring of 1860. It is the oldest in Cache Valley and the first to divert water from Bear River or its tributaries. The primary object of the original water users was to irrigate wheat lands but several mill owners obtained permission to widen the canal enough to furnish them with a power supply. Water from the mills was subsequently used to irrigate additional land.

At present, the total number of acres irrigated by both branches of the canal averages about 2,800 acres of which 1,215 acres are located in Hyde Park and the remainder in Logan area (9). Much of the Logan North Field ditch irrigates city lots.

Logan Northwest Field and Benson Ward Canal

The headgates of Logan and Benson Ward Canal are located near the business center of Logan. Its appropriation extends back to 1861. The irrigated land totals 1,000 acres in Benson Ward and 2,400 acres in Logan precinct.

When the Benson Canal was lengthened, irrigators dug the canal in proportion to the new land they were to irrigate and were given

proportionate shares according to their labor. This is how many early irrigators acquired water rights. The earliest right on this canal is dated 1860.

The Logan Northern Irrigation Company

Begun in 1864, this canal was finished in May 1865 and watered lands in Logan, Hyde Park, Smithfield, and Richmond. The canal furnished water for 2,400 acres.

In 1880, the canal bottom was widened from 9 to 13 feet and an additional 1,300 acres were brought under irrigation. The canal now irrigates 3,700 acres of land (10, p. 20-21).

Water Distribution

Early engineering work

Samuel Fortier, Professor of Irrigation Engineering at the Utah State College of Agriculture, made the first measurements on the Logan River and on various canals in 1883. Fortier thought that the best defense in case of legal conflict would be competent measurement. His successor at the college, Professor O. L. Swendson, continued to measure the various canals periodically.

The work of these early engineers didn't go unnoticed by the irrigators, as they could see its value because the engineers could then advise them how best to distribute the water. Mr. A. O. Barber, a local businessman, helped compile and summarize their findings and issued a report in 1902. In this report, known as the Barber-Swendson report, were given the priority date of the canal, the maximum flow, and the cubic-feet-per-second diversion from Logan River.

The Barber-Swendson report was not a legal document. It was only an informational report of a study which had been made by request of irrigators on the Logan River to aid in the distribution of the water.

Division of water among canals

The amount of water taken by the Logan River Canals until about 1900 was usually limited only by their capacity. This was possible because of the usually abundant stream flow. The problem of dividing the water received attention only during seasons of scarcity. When one period of difficulty had passed, the question was not thought of until another shortage occurred. Therefore, there was no system of canal allocations until 1912. The watermasters of the various canals would regulate the diversion gates and regulate supply to suit the demand of the irrigators as far as the capacity of the canal would permit (31).

Distribution among farmers

While no established system of measurement was used to divide the water among irrigators, there was an effort to allocate the water according to rights. The division was usually made by an ordinary rectangular diversion box fitted with a vertical gate. These gates were raised a definite number of inches for an irrigating stream which was a proportion of the canal flow. For instance, the water in one canal is divided into 30 irrigating streams. These 30 streams are rotated among those entitled to water. Each irrigator has the stream for a period of time, the length of which depends upon his interest in the canal. Where water is divided on this basis, the size variation of the different streams becomes a matter of importance.

During 1900, C. L. Swendson made a large number of measurements on one of the canals where streams were apportioned on a time basis. A portable weir was used to make the measurements and showed that the stream sizes, instead of being equal as they should have been, varied from .85 cubic feet to 1.96 cubic feet per second. When water is distributed on the basis of acreage, and an irrigator is allowed enough water to irrigate his land, the size of the stream is not a matter of great importance except as it requires a shorter or longer time to irrigate (31). When the water turn is governed by length of time, however, the situation changes and the problem of equal amounts of water per period becomes critical.

WATER RIGHT LAWS AND ADMINISTRATION

In the early days of Utah history, general civil authority was vested in county courts, presided over by a probate judge, who was usually a Mormon in good standing. Because of this primitive but effective arrangement between civil office and church position, the local authorities took the responsibility of controlling water use for mills and irrigation.

Probate judges had the power to appoint county seats, grant concessions (within the county) for toll roads, timber stands, and saw and grist mills, grazing rights, etc. On March 5, 1860, Peter Maughan, probate judge, designated Logan as the county seat of Cache County.

The Territorial Legislature granted cities the right to incorporate and levy taxes for school purposes and to regulate water supplies for the benefit of the city.

On January 17, 1866, the Legislature passed an act to incorporate the city of Logan. From its incorporation until 1880, Logan City had almost complete control of water in the general area. In this year, however, a new territorial law removed the authority to issue water rights from the probate judges and transferred it to new officers which were called selectmen or water commissioners.

This act provided that the selectmen of the several counties of the territory were created ex-officio water commissioners for their respective counties. Their powers and duties were to:

> Determine the average flow thereof at any season of the year, and to receive, hear and determine all claims to the use

> of water, and on receipt of satisfactory proof of any right to the use of water having vested, to issue to the person owning such right a certificate for recording and to generally oversee, in person, the distribution of water in their respective counties. . . and to fairly distribute according to law, to each of said corporation, or persons, their several portions of such water; and in case of dispute. . . to hear and decide upon all such disputed rights. . . . (20, p. 36)

The selectmen or water commissioners were an intermediate step from the probate court to the state engineer which is the present authority in water disputes.

Upon passage of this law the city council asked the Committee on Irrigation to make a report on the new law and express an opinion as to whether the city should file claim for more water with the county commissioners. The council members were of the opinion that Logan City already had enough vested water rights to supply all their needs. Nine years later, however, the mayor was urging the council to secure additional water for the city's water needs (16).

The Authority of the State Engineer

The first comprehensive water law for Utah was enacted in 1903. This major change in water right legislation placed all water administration in the hands of the state engineer and initiated a new procedure for acquiring water rights. His office was given general supervision of the waters of the state, their measurement, apportionment and appropriation. At the time, 1903, the state engineer was commissiondd to make a complete hydrographic survey of each river system and water course of the state, beginning with those most used for irrigation. The state engineer was to examine all water rights on all streams of the state and issue a report. The Logan River was one of the first streams investigated.

On January 20, 1906, all the water users from the Logan River system grouped together to form an organization called the Logan River Water Users Association. The purpose of this organization was to devise ways and means for just settlements of all controversies among organization members concerning the division and use of water; also to protect water rights of the members of the Logan River from interference or injury by any non-member of the association. They desired to consider, propose, and if possible, to secure the passage of such legislation concerning water, water courses, and irrigation as would be of benefit to their members as well as the community at large and to urge and assist the proper authorities in the enforcement of all laws pertaining to the system.

In 1912, the irrigators on the Logan River system were given notice to file their claims to water rights with the state engineer. There was considerable resentment because the claims were to be based on (a) the flow per second, (b) the dimension grade, slope, and nature of the diverting channel when the diverting channel was completed, (c) time when water was used during the first year, and (d) every change in manner of use, etc. All claims which were not recorded as required would be forfeited.

The local newspaper, The Logan Journal, on August 10, 1912, expressed this resentment:

> To fully establish his claim under the condition required, would require him to employ the services of an engineer or attorney to obtain the records--if any were kept, which is doubtful--of his canal or ditch company and the sworn statement of old residents. And in addition, he would have to be blessed with a very long and accurate memory.
>
> In behalf of the hundreds of water users in the Logan River district we appeal to the state engineer for aid to some simpler methods of establishing rights, if he may, under law suggest them.

He and every other old resident must know that not more than one water user in one hundred can tell the number of second feet flowing in the canal from which he draws his supply, and not one in a thousand could tell the number of inches or amount of flow to which he is entitled.

Suppose that each individual files a separate claim and the canal companies each file claims. It would be safe to assert that the individuals claims would represent a volume of water 10 times as large as Logan River, and several times larger than the total aggregate claims made by the canal companies, for which they have a record.

The logical way would have been to make each canal or ditch company prove its claim and leave to it the apportionment among the several stock holders.

We appeal to State Engineer Tanner for an explanation of the simplest form of proof that will be accepted, and for any information he can give that will be of aid in the required proof making, for the law, as read by the layman, is impracticable and impossible (27).

As it eventually turned out, all the water rights on the Logan River were granted to the canal companies and the apportionment was up to them.

Water Law

The Utah Code Annotated, 1953, relative to water law, now reads:

All waters in this state, whether above or underground, are hereby declared to be the property of the public, subject to all existing rights to the use thereof.

Beneficial use shall be the basis. . . to the use of the water.

Right to use the water is based on 'first in time, first in right.' (3h, 73-1-1, 73-1-3, 73-3-21)

It often happens that the chief value of an appropriation lies in its priority over other appropriations from the same natural stream. Hence, to deprive a person from his priority is to deprive him of a most valuable property right. (3h, Whitmore vs Murray City, 107 U. hh5, 15h p. 2d 7h8, 151)

The amendment in 19h3 made water rights represented by shares of stock in a corporation, presumably not appurtenant (to the land) and hence such a water right, even though not expressly reserved in the deed, would not pass to the grantee in the absence of clear and convincing evidence that the grantor so intended. In other words, amendment in 19h3 merely

> obviated the necessity for a grantor, who owned a water right represented by shares of stock in a corporation, but who did not desire to transfer that water right to the grantee of the land upon which the water was being used.
>
> Any person entitled to the use of water may change the place of diversion or use and may use the water for other purposes than those for which it was originally appropriated, but no such change shall be made if it impairs any vested right without just compensation. (34, 73-1-10, Bunn vs. Cache Valley Banking Co. U (2d) 93 269 p. 2d 859 864)

No permanent change shall be made except on the approval of an application by the state engineer. If upon investigation such a temporary change does not impair any rights of others, the engineer shall authorize the change.

Ciriacy-Wantrup argues that appropriation rights are far better suited for transfer than riparian rights because the former are clearly defined in quantity, seasonal distribution, priority, point of diversion, and other ways. However, there are rigidities which bring security to water rights, which may hinder economic change to new uses that may be economically desirable (5, p. 880).

The added involvement in litigation and the inconvenience of having to submit proposals of change to an administrative agency or the courts might have a dampening effect on transfers (1, pp. 1-8).

The law itself doesn't prohibit transfer provided third party loosers are justly compensated. Most of the canals require all transfers be made by 1 April. There are some problems in this procedure of inhibiting transfer in the short run. The burden of proof for showing that there are no third party loosers is on the man wishing to make the transfer. This requires application to the state engineer, public hearings and notices, etc., all in which requires time. There is certainly not time for all of this to take place if a man urgently needs irrigation water.

The normal procedure for change of point of diversion is as follows:

Since all water is decreed to the irrigation companies, an individual must first obtain approval from the companies involved in the exchange. After the companies agree to a change, application is sent to the local water commissioner, who views the application. It is then sent to Salt Lake City and then it must be advertised one day each week for three consecutive weeks. Then one month must elapse to allow all protests to be submitted. If no protests occur, then the State engineer can approve the transfer. The minimum time involved in making such a transfer would be three months. This would naturally preclude any transfers during the irrigation season.

Water rights define property relationships which are basic to both private and public action. Public policy is important to water resource economics (28).

LEGAL DECREES AND LITIGATION

There were very few early water litigations in Utah because there were no water shortages and because of the ecclesiastical authority which the Mormon leaders wielded over the church members. Problems were settled by the bishop of the ward or the stake president and high council. As long as capable leadership was directing the activity, there were few problems which could not be resolved. The counsel of the L.D.S. Church was: "No one has the right to waste a drop of water which someone else can use." Most of the early watermasters were men of considerable experience and leadership. However, when men of lesser ability were in charge, things didn't run as smoothly. This is not to say that there were no disputes in the first 30 years of the Logan River System, but they usually were handled out of court.

One such dispute had its beginning in 1873 when the city council decided to tax all land and machinery for the repairs on the ditches. Early territorial law gave incorporated cities the power to tax and regulate irrigation water for certain purposes.

> The city council is further empowered to assess and collect and expend the necessary tax for school purposes and for furnishing the city water for irrigating and other purposes, and regulate and control the same, and furthermore, so far as it may be necessary, control the water courses leading thereto. (33, p. 401).

Since the upper canals (Logan, Hyde Park, Smithfield and Logan Northern) had been built by the land owners and were maintained by them, taxing them for maintenance of the lower canals constituted a double tax for the property owners of the upper canals. This controversy

lasted for more than 20 years and was not fully resolved until about 1912. As headgates were built on the stream by the various canal companies, many disputes began to arise. It was feared that the upper canals were diverting more than their share, not leaving enough for the last user's right on the lower end of the River. It was this type of situation which precipitated the first real dispute on the Logan River. In 1914, the Barber-Swendson report received its first test.

The Call Decree

In January 1915, the irrigators on the lower canals filed a complaint against the power and irrigation users of the upper canal and the Utah Agricultural College. The only rights which Logan City had were its one-third share in the Logan, Hyde Park and Smithfield Canal and its rights to produce power further upstream. The Utah Agricultural College was a party to the suit because of the supposed seepage losses in the dam which they had built. A representative of the Logan River Water Users and one representing the Agricultural College and a third disinterested party, viz the state engineer, determined the extent of the probable loss on the dam. Physical measurements were taken between September 9 and October 17, 1916, and a report was issued November 30, 1916 (16, p. 66).

The main complaint charged that Logan City had previously been using approximately 10 cubic feet per second for its culinary needs from the Logan, Hyde Park and Smithfield Canal. The city had just completed its pipe line from DeWitt Springs and this caused a marked reduction in the flow diverted by the Logan, Hyde Park and Smithfield Canal which in turn diminished the flow downstream. The downstream users thus felt that users on the upper canal would get more than they were entitled to.

When the final decree was issued, Logan City surrendered stock in the upper canal to receive a vested right in the River from the lower canal.

While the suit was going on, users on both sides together with their engineers worked out an agreeable solution. This resulted in the state engineer drawing up 12 schedules for use during the year. The water users would receive a proportionate share of water depending on the flow of the canal and the number of acres or shares which they held.

The final court decree, signed by Judge D. Call on December 31, 1916, stipulated that the irrigation season began on April 15 each year and continued until October 15. It also stipulated that all parties must install at their own expense, at point of diversion, adequate dams and measuring devices to enable watermasters to distribute water according to the decree.

If any disagreement were to follow or any canal diverting water failed to build the necessary measuring devices, the court would have power to appoint a water commissioner to enforce the decree (16, p. 70).

The Kimball Decree

Shortly after the Call decree, another suit was filed to determine water rights, this time on the Bear River of which Logan River is a tributary. This complaint was filed August 21, 1917, by the Utah Power and Light Company against all the water users on the Bear River. The company wanted to expand, but because of the vague and undetermined water rights, expansion could not take place.

Nearly five years were required to receive all claims and to hear testimony. The case was finally settled on February 21, 1922, when Judge James N. Kimball signed the court decree. The Kimball decree follows the Call decree very closely with only minor modifications. There were

12 schedules with three major divisions in the Call decree, but this was reduced to just one schedule in the new Kimball decree as shown in Table 1. Logan City's right of 10 cubic feet per second from DeWitt Springs was not changed except that when stream flow is below 220 cubic feet per second, the city's right drops from 10 to 8.4 cubic feet per second. The city only receives 5 cubic feet per second when Logan River flow is only 150 cubic feet per second as shown in Table 2.

One part of the decree classified rights as "Power Rights," "Irrigation Rights," and "Domestic Rights" with the following characteristics:

"Power Rights" include the rights to divert and use water for the generation of electric power and such rights of diversion and use as are continuous throughout the year without limitation to time or season.

"Irrigation Rights" include the rights to divert and use water for irrigation and agricultural purposes and as a part of culinary, domestic and stock watering purposes throughout the irrigation season of each year. The irrigation season was defined as that portion of each calendar year which commences on April 1 and closes September 30. This was a change from the Call decree which stated that the season began April 15 and ended October 15 each year.

> The water allotted and decreed to the parties hereto for irrigation purposes shall be used upon the land upon which the same is now applied and used as described in the schedule, subject, however, to the rights of appropriations or shareholders in any appropriating company to change the place of diversion or use or manner of use, as provided by law.
>
> Nothing herein contained shall be construed as limiting the right of the parties hereto by agreement between all parties hereto by agreement between all parties in interest, to use the water herein decreed to those parties respectively, by rotation among themselves at such time and such manner as they may determine, provided that in so doing they do not infringe upon the rights of the other appropriators as herein described.

Table 2. Schedule A of the original decree signed by honorable James A. Kimball, 1922.

Logan River flow in second feet	120	130	140	150	160	170	180	190	200	210	220	230	240	250	260
Logan, Hyde Park & Smithfield	21.6	23.4	25.2	27.0	28.8	30.6	32.4	34.2	36.0	37.8	39.6	40.2	42.4	44.6	46.8
Thos. Smart															
Logan & Northern Irr. Co.	27.6	29.9	32.2	34.5	36.8	39.1	41.4	43.7	46.0	48.3	50.6	52.9	55.2	57.5	59.8
Providence-Logan Irr. Co.	3.9	4.2	4.6	4.9	5.2	5.5	5.9	6.2	6.5	6.8	7.2	7.5	7.8	8.1	8.5
Providence Pioneer Irr. Co.	1.6	1.7	1.8	2.0	2.1	2.2	2.4	2.5	2.6	2.8	2.9	3.0	3.2	3.3	3.4
Hyde Park Irr. Co. Logan Northfield Irr. Co.	16.5	17.9	19.3	20.7	22.1	23.4	24.8	26.2	27.6	29.0	30.3	31.7	33.4	34.5	35.9
Logan Northwest Field Irr. Co., Benson Irr. Co.	20.1	21.8	23.5	25.2	26.8	28.5	30.2	31.9	33.5	35.2	36.9	38.6	40.8	41.9	43.6
Logan Hollow	0.7	0.7	0.8	0.8	0.9	1.0	1.0	1.1	1.1	1.2	1.3	1.3	1.4	1.4	1.5
Logan Island Irr. Co.	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2
Seventh Ward Irr. Co.	3.6	4.0	4.3	4.6	4.9	5.2	5.5	5.8	6.1	6.4	6.7	7.0	7.3	7.6	7.9
Thatcher Irr. Co.	0.7	0.8	0.8	0.9	0.9	1.0	1.0	1.1	1.2	1.2	1.3	1.3	1.4	1.4	1.5
Logan City	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.5
Logan Stone & Monument Co.	4.6	5.0	5.4	5.7	6.1	6.5	6.9	7.3	7.7	8.8	8.4	10.0	10.0	10.0	10.0
Thatcher Milling & Elevator Co.	3.7	4.0	4.3	4.6	4.9	5.2	5.5	5.8	6.1	6.4	6.7	7.0	7.3	7.6	8.0
Central Milling & Elevator Co.	36.5	39.5	42.5	45.5	48.7	51.7	54.7	57.7	60.8	63.9	66.9	69.9	72.9	76.0	79.0
Thatcher M. & E. Co.	11.9	13.0	13.9	14.8	15.9	16.8	17.8	18.8	19.8	20.7	21.8	22.6	22.6	22.6	22.6
Anderson & Sons Co.	20.9	22.7	24.4	26.2	27.9	29.6	31.4	33.2	34.8	36.6	38.3	39.9	33.9	39.9	39.9
Utah Power & Light Co. (Card Right)	7.7	8.3	9.0	9.6	10.2	10.9	11.5	12.2	12.8	13.4	14.1	14.7	15.4	16.0	16.6
Utah Power & Light Co.	9.4	10.2	11.0	11.8	12.6	13.3	14.1	15.0	15.7	16.5	17.2	18.0	18.9	19.6	20.4
	93.8	101.6	109.4	117.2	125.6	132.9	140.7	148.5	156.3	164.1	171.9	179.8	187.6	194.5	200.0

Source: (34)

Logan River flow in second feet	263	264	265	266	267	270	280	290	300	310	320	330	340	350	360	370	380	390	400
Logan, Hyde Park & Smithfield	47.4	47.4	47.4	47.4	47.4	48.3	51.2	54.0	60.0	65.9	72.2	76.0	79.7	83.5	87.3	81.1	85.1	99.1	103.2
Thos. Smart		1.1	2.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Logan & Northern Irr. Co.	60.5	60.5	60.5	60.5	60.5	61.2	63.5	65.8	68.1	70.4	72.3	76.0	79.7	83.5	87.3	91.1	95.1	99.1	103.2
Providence-Logan Irr. Co.	8.6	8.6	8.6	8.6	8.6	8.7	9.0	9.3	9.6	10.0	10.3	10.8	11.4	11.9	12.4	13.0	13.5	14.1	14.7
Providence Pioneer Irr. Co.	3.5	3.5	3.5	3.5	3.5	3.5	3.6	3.8	3.9	4.0	4.2	4.4	4.6	4.8	5.0	5.3	5.5	5.7	6.0
Hyde Park Irr. Co. Logan Northfield Irr. Co.	36.2	36.2	36.2	36.2	36.2	36.5	37.2	37.9	38.5	39.2	39.9	40.6	41.3	42.0	43.7	43.7	44.1	44.7	45.4
Logan Northwest Field Irr. Co., Benson Irr. Co.	44.1	44.1	44.1	44.1	44.1	44.6	46.3	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0
Logan Hollow	1.5	1.5	1.5	1.5	1.5	1.5	1.6	1.6	1.7	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.5
Logan Island Irr. Co.	5.2	5.2	5.2	5.2	5.2	5.3	5.5	5.7	5.9	6.1	6.3	6.6	6.9	7.2	7.6	7.9	8.2	8.6	9.0
Seventh Ward Irr. Co.	8.1	8.1	8.1	8.1	8.1	8.1	8.4	8.7	9.0	9.3	9.7	10.2	10.7	11.2	11.5	12.2	12.2	12.2	12.2
Thatcher Irr. Co.	1.5	1.5	1.5	1.5	1.5	1.5	1.6	1.7	1.7	1.7	1.9	1.9	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Logan City	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.8	0.8
Logan Stone & Monument Co.	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Thatcher Milling & Elevator Co.	8.0	8.0	8.0	8.0	8.0	8.1	8.5	8.7	9.1	9.4	9.7	10.2	10.7	11.2	11.7	12.2	12.2	12.2	12.2
Central Milling & Elevator Co.	80.0	80.0	80.0	80.0	80.0	80.8	83.9	87.0	87.0	87.0	87.0	87.0	87.0	87.0	87.0	87.0	87.0	87.0	87.0
Thatcher M. & E. Co.	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6
Anderson & Sons Co.	39.9	39.9	39.9	39.9	39.9	39.9	39.9	39.9	39.9	39.8	39.8	39.8	39.8	39.8	39.8	39.8	39.8	39.8	39.8
Utah Power & Light Co. (Card Right)	16.8	16.8	16.8	16.8	16.8	17.0	17.7	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3
Utah Power & Light Co.	20.7	20.7	20.7	20.7	20.7	20.9	21.8	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6
	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0

> The several parties hereto are also hereby adjudged and decreed to have the right to divert and use so much of the water of said streams during the non-irrigating season, ie., between the 1st day of October and the 31st day of the succeeding March as they may reasonably require for their domestic, culinary or other specific beneficial purposes, which rights are to be recognized and administered specifically as decreed. (35)

Logan City vs. Logan River Water Users (1926)

For some unknown reason the city of Logan failed to assert any right to use water for power when the Kimball decree was made. In 1926, the city of Logan constructed a dam for increased power facilities. They posted notice, as prescribed by law, with the intention of appropriating 300 cubic feet per second from the Logan River for power purposes.

The new dam provided additional water storage necessary to generate the needed power. The city began holding water during the day and releasing it in the evening when power demands were the greatest. This manipulation of the river flow irritated the users who didn't care to irrigate at night. The Utah Power and Light Company which had power facilities downstream from the Logan City plant also complained. Variation in river flow was as much as 60 cubic feet per second and the canals of the irrigators were half full during the day and overflowing at night (8, p. 100-110).

As Logan City refused to keep river flow constant, the water users filed a complaint July 10, 1926. The court ruled that inasmuch as the city had filed claim for domestic water but failed to file for power rights, its rights for power had been forfeited. The court also ruled that the city was not to regulate the waters in the future.

The city of Logan continued to regulate the flow as they took the case to the State Supreme Court. The State Supreme Court upheld the lower court's decision and ordered the city of Logan to stop regulating the flow. However, the State Supreme Court did alter the ruling of the lower court by granting a right for the Logan city to use the water for power purposes but this was to be junior to all other rights (16, p. 77) (8, p. 112).

Logan City vs. Water Users (1963)

The period between 1923 and 1960 was one of relative peace. The canals irrigated approximately the same acreage as before. However, Logan City grew and had to expand the capacity of its pipeline from DeWitt Springs. This action was necessary to meet the needs of increased population and increased water consumption resulting from the modern conveniences such as bathrooms, automatic washers, lawn sprinkling, and yard upkeep. The people were using more water per capita than 20 years ago. The old wooden stave pipe which had been installed in 1911 had a capacity of 9.3 cubic feet per second which was within the limits prescribed in the old Kimball decree. When the new steel pipeline was completed in 1949, the capacity was increased to nearly 20 cubic feet per second. Additional storage was built above the golf course to handle the extra water, but no additional water rights were obtained.

Because of the peace which existed for so many years, the water users did not yet feel the need for a commissioner to handle the distribution of water. When water supply was sufficient no one wanted to "kick a sleeping dog." As a result, no records were kept of the increasing water use of Logan City.

Because Logan City locked the doors to the gate house at DeWitt Springs and the device which measured the water (a venturi meter) was not operating, no one knew just how much water Logan City was using.

In 1957, Frank Haws was employed as "engineer" for the Logan River Water Users and was to distribute the water according to the Kimball Decree. Upon receiving a key to the gate house from the city, Mr. Haws found no measuring devices in operation so he proceeded to install a meter to record the flow. Measurements showed that the city was using approximately 20 cubic feet per second which was 10 cubic feet per second more than its decreed rights, according to schedule of the Kimball decree. When Mr. Haws reported this to the Logan River Water Users in the fall of 1957, they "discovered" Logan City was "cheating." As it was late in the year, the irrigators could do little but express a verbal complaint.

The following year, Mr. Haws was appointed "engineer" and in trying to distribute water according to the decree found new locks on the gate house and was denied entrance. As water was evidently sufficient, the water users were slow to react until August 13, 1960, when the Logan, Hyde Park and Smithfield Canal Company filed a petition with the county clerk to show cause for not letting the "engineer" have access to the measuring device.

The court then gave permission to make periodic measurements at DeWitt Springs for the rest of the irrigation year. Frank Haws, along with the city water superintendent and another engineer, measured the flow as given in Table 3 (16, p. 82).

In January 1961, the water users petitioned the state engineer, Wayne Criddle, to appoint a water commissioner to apportion the water on the Logan River System. Frank Haws was subsequently appointed

Table 3. Flow of DeWitt Springs, 1960

Date	Discharge cfs	Total river flow cfs	Allowed by "Schedule A"
August 25	19.15	165	6.3
30	18.63	156	5.9
Sept. 2	15.63	159	6.1
6	14.50	150	5.7
9	14.83	149	5.7
13	14.83	144	5.5
19	14.50	144	5.5

commissioner March 30, 1961 with powers to enforce the court decrees as set forth (2, 1961, p. 2).

As 1961 was a dry year and everyone was water conscious, Logan City and the state engineer were advised early in July that the city was exceeding its rights. The state engineer ordered the commissioner to enforce the decree beginning July 17, 1961, whereupon the city of Logan appealed and entered a condemnation suit against the Logan River Water Users in order to permit them to continue using the water. This delayed the case until later in the year. The trial date was finally set for November 29, 1961. Logan City tried to prove that they had right to the water because it merely had been using "abandoned" water since 1949. The city made application for this "abandoned" water to the state engineer. This was rejected by the state engineer and also by the courts.

"Abandonment is separate and distinct from forfeiture by non-use. In order to constitute an abandonment of a water right, there must be an intent to abandon, coupled with some act of relinquishment by which the intent is carried out." (34, p. 47)

The Utah Code states "when an appropriator or his successors in interest shall abandon or cease to use water for a period of five years, the right shall cease. . . ." (34, p. 47)

To prove that the water was abandoned it was necessary to prove the water would have gone on down the stream and not used by the irrigators, but the irrigators did not have the chance to use the water as it was taken out above the irrigators. From this, the irrigators proved the city was taking adverse possession of the water and therefore subject to the rulings of the court.

The Utah Legislature had applied this stipulation to the water law in 1939: "No right to use the water, either appropriated or unappropriated can be acquired by adverse possession." (Utah Code 1943) (L. 39, C 111, p. 148)

City officials realized that their water position was not strong so they tried to delay the actions of the court as long as possible.

In 1962, Logan applied for and received permission to dig four deep wells. The first of these was completed in the summer of 1962 and produced 8 cubic feet per second. The second well produced 11 cubic feet per second and was completed in 1963. The other two were completed in 1964. The combined yield of these four wells gave the city a capacity of 41 cubic feet per second.

All of these wells are so located that they can pump water into the irrigation canals or into the city system. This gave the city the ability to replace the water from DeWitt Springs over and above its decreed amount, with an equal amount from its wells (2, 1963, Appendix 10).

Agreement to exchange

A committee of engineers, Frank Haws, Alvin Bishop, and William Templeton, were chosen to set a fair price at which water would be exchanged. They concluded that $4 per acre-foot would be a fair market value (2, p. 3)

On June 26, 1963, the Logan River Water Users Association agreed to let Logan City divert water in excess of its decreed rights. Logan City in turn agreed to pay $4 for each acre-foot diverted. The City also agreed to sell the Association water pumped from its underground storage, through any or all of its wells, for $4 per acre-foot. Actual exchange of funds occurs only when the amount of water diverted from one source is greater than the amount diverted from the other source (2, 1963, Appendix 10(6)). Under this 1963 agreement, the Logan River Water Users purchased 99 acre-feet from the Logan City (2, 1963, Appendix 7). In all the successive years, the Logan City purchased water from the Logan River Water Users, 810 acre-feet in 1964, 511 in 1965, and 681 acre-feet in 1966 (2, 1964, Appendix 7; 1965, Appendix 8g; 1966, Appendix 7g). Because 1966 was a drier year than 1963, as indicated in Figure 2, it would be logical to assume that the Water Users would use more water from the city wells. However, this was not the case. Instead, they sold 681 acre-feet to the city that year. The Water Users, therefore, have a surplus of water even in dry years which they are willing to sell Logan City for $4 per acre-foot. This would indicate that the farmers value water below $4 per acre-foot. This agreement is shown in the Appendix on page 87.

Both parties agreed to review and renegotiate the water rate every three years (2, 1963, p. 3).

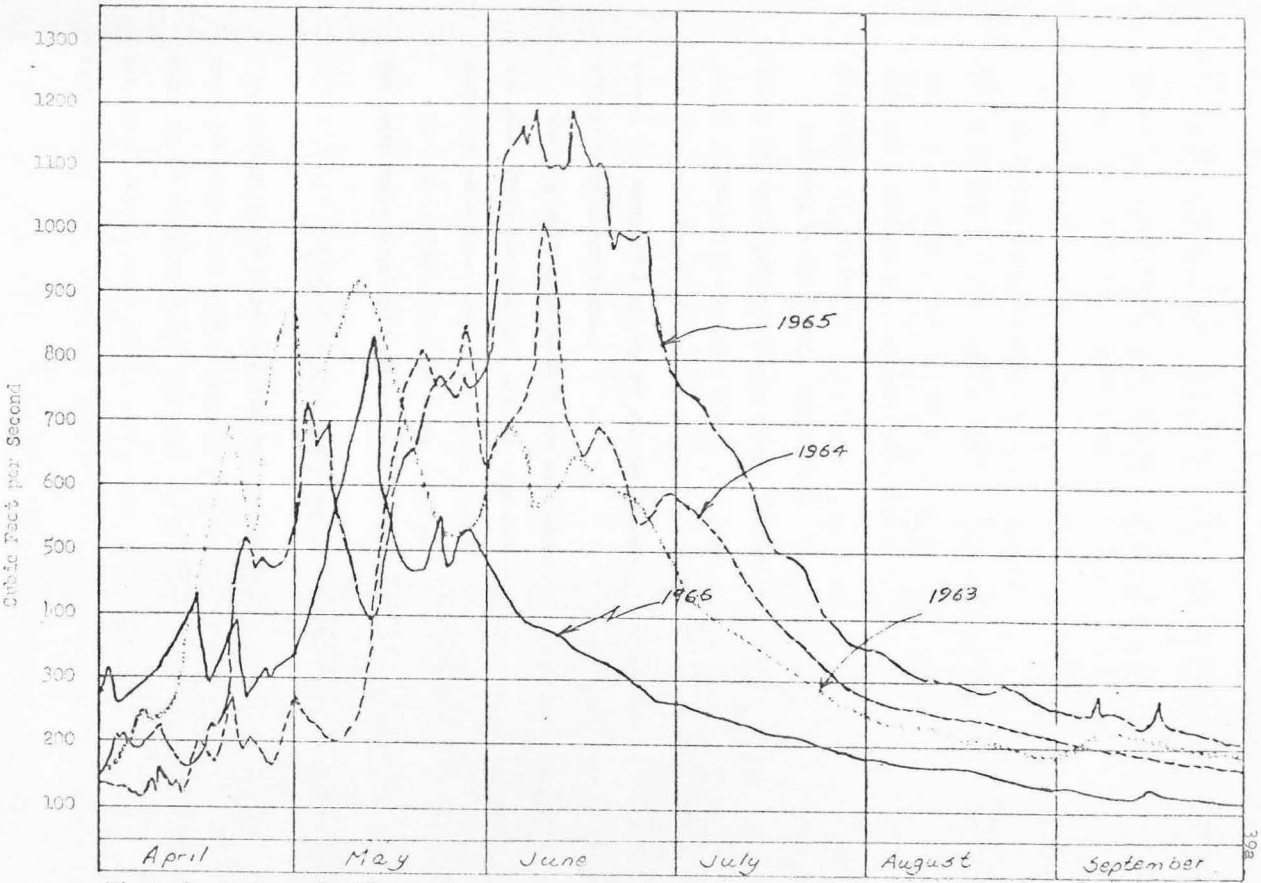

Figure 2. Hydrograph of Logan River

Source: (2)

Since Utah Power and Light was adversely affected by this exchange agreement, it was decided that Logan City should pay the power company for any loss of revenue sustained when diverting water in excess of its decreed rights (2, 1963, p. 3).

On July 8, 1963, the final decree was signed by Judge Lewis Jones. It awarded Logan City a constant flow of 10 cubic feet per second as indicated in Table 4, with a superiority of all rights. However, the city was restrained from exceeding this amount without exchange or remuneration for the excess.

According to the Kimball decree (Table 2) and the revised schedule (Table 4), the regulation starts after a flow of 400 cubic feet per second is reached on the Logan River. The Logan River generally reaches that flow near the first of July (Figure 2). This means that it is only during the months of July, August and the first part of September that effective rationing occurs.

The city wells have acted in the same capacity as a reservoir which the water users can draw upon and the city does transfer a significant amount of water from these wells to the irrigators.

The city of Logan paid the Water Users the sum of $15,746.50 for the extra water which had been consumed during the trial (16, p. 102).

Local Customs of Water Transfer

Usually, water rights are transferred when land is sold. There are a few cases where land is sold for suburban housing development and water is not transferred with the land. In this case, the farmer may use the additional water on his existing land or sell or rent out the extra water. Many farmers have purchased or rented extra water as an

Table 4. Revised appropriation of schedule A of the Kimball Decree, 1963.

Logan River flow in second feet	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300	310	320	330	340	350	360	370	380	390	400
	Appropriations																														
Logan City	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Logan, Hyde Park & Smithfield	20.2	22.4	24.6	26.9	29.1	31.4	33.6	35.8	38.1	40.3	42.6	44.8	47.0	49.4	51.5	53.7	56.0	57.3	59.5	59.5	70.8	75.3	79.8	84.3	88.8	93.3	97.8	102.3	103.2	109.3	116.0
Logan Northern	22.9	25.4	27.9	30.5	33.0	35.5	38.1	40.6	43.2	45.7	48.2	50.8	53.3	56.0	58.4	61.0	63.3	65.0	67.5	67.5	70.8	75.8	79.8	84.8	88.8	93.8	97.8	102.3	103.2	106.1	109.4
Logan Hollow	0.6	0.6	0.7	0.7	0.9	0.9	0.9	1.0	1.1	1.1	1.2	1.2	1.3	1.3	1.4	1.4	1.6	1.6	1.7	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.5	2.5	2.5
Providence-Logan	3.2	3.6	3.9	4.3	4.6	5.0	5.3	5.7	6.0	6.4	6.8	7.1	7.5	7.5	8.2	8.6	9.0	9.2	9.5	9.5	10.1	10.7	11.4	12.0	12.6	13.3	13.9	14.6	14.7	14.7	14.7
8th Ward Diversions	41.7	46.5	51.2	55.8	60.5	65.1	69.8	74.4	79.0	83.7	88.3	93.0	97.7	102.4	107.0	111.6	116.3	119.0	123.8	123.8	128.4	128.4	128.4	128.4	128.4	128.4	128.4	128.4	136.4	137.4	137.4
Logan Island	6.9	7.7	8.4	9.2	10.0	10.7	11.5	12.3	13.0	13.8	14.6	15.3	16.1	16.9	17.7	18.4	19.2	19.6	20.4	20.4	21.2	21.2	21.2	21.2	21.2	21.2	21.2	21.2	20.9	21.4	21.4
7th Ward	0.7	0.8	0.9	0.9	1.0	1.1	1.2	1.2	1.3	1.4	1.5	1.6	1.6	1.7	1.8	1.9	1.9	2.0	2.1	2.1	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.0	2.0	2.0
Hyde Park & Logan North Field	14.8	16.5	18.1	19.8	21.4	23.0	24.7	26.3	28.0	29.6	31.3	32.9	34.6	36.2	37.9	39.5	41.2	42.1	43.8	43.8	45.5	45.5	45.5	45.5	45.5	45.5	45.5	45.5	44.7	45.0	45.0
Thatcher Irr. Co.	0.3	0.3	0.3	0.4	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.8	0.8	0.8
Logan Northwest Field & Benson	15.5	17.3	19.0	20.7	22.4	24.2	25.9	27.6	29.3	31.1	32.8	34.5	36.2	38.0	39.7	41.4	43.1	44.1	46.0	46.0	47.6	47.6	47.6	47.6	47.6	47.6	47.6	47.6	47.3	47.7	47.7
Southwest Field	3.6	4.0	4.4	4.8	5.2	5.6	6.0	6.4	6.8	7.2	7.6	8.0	8.4	8.8	9.2	9.6	10.0	10.3	10.7	10.7	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	10.8	10.9	10.9
Logan Cow Pasture	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.7	8.9	8.9
Providence-Pioneer	1.4	1.5	1.7	1.8	2.0	2.1	2.3	2.5	2.6	2.8	2.9	3.1	3.2	3.4	3.5	3.7	3.8	3.9	4.0	4.1	4.1	4.4	4.6	4.9	5.2	5.4	5.7	5.9	6.0	6.0	6.0
Hyrum Gibbons	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0

insurance against dry years.

On lower canals, irrigators use a stream until they finish, then pass it on to the neighbor. Water is not measured exactly, so the user doesn't know exactly what he has received, nor what he is entitled to. This system is certainly not conducive to water intercompany transfer nor to the most economical (profitable) use of water.

Where companies are small, physical limitations, such as size of ditch make difficult to effect transfer. The ditch may be too small to carry the extra water. Within the small companies, structural enlargement would be possible if water were to be had over the long run whereas it would not pay to make these changes for just one year.

On the Logan, Hyde Park and Smithfield Canal a gravity flow sprinkling system which measures all water serves to irrigate 75 percent of the land. Here, a share of water represents a definite proportion of the stream flow. The city of North Logan has purchased extra water shares for future use. This they are presently renting to farmers. A turkey farm (now out of business) and certain individuals also have extra water shares for rent.

Variable Supply

Enough springs flow into the Logan River to assure a relatively stable water supply even after all the snow has melted. In early June, when runoff is greatest, irrigators are only limited by their canal capacity except in very dry years. Water demand is the highest in late June or early July when farmers are irrigating grain for the last time and alfalfa for the first time after the first cutting. After this two- or three-week period, the demand for water declines as the stream

flow diminishes. Only in 1961 and 1966 did decreed rights exceed the June river flow (Figure 2). With the additional water supply available from Logan City, there has been no real water shortage since the wells were drilled. In fact, the irrigators have yet to use the full capacity of the city's wells.

The year 1966 was one of below normal water supply. "The flow of Logan River for the period of April through September was 109,200 acre-feet as compared to 188,800 acre-feet for the same period in 1965, a decrease of 42 percent." (2, 1966, p. 1)

Because snow survey reports indicated there would be a water shortage in 1966, irrigators began using water earlier than usual which helped relieve the apparent shortage. Even though the river flow was low during July and August, it was generally sufficient for most crops. Although more water could have been used during the early part of July, irrigators didn't ask for well water until August 2, 1966. Even then, only one well was pumped. The total use of irrigation and municipal water during 1966 was 69,184 acre-feet as compared to 74,664 acre-feet in 1965 which was a decrease of 5,480 acre-feet or 7.3 percent. The water pumped by the city was purchased by the Logan, Hyde Park, and Smithfield Canal Company. The soil watered by this canal is more gravelly and thus requires more water. None of the other canal companies demanded water (2, 1966, p. 2).

EVALUATION AND PRESENT ALLOCATION

Utah water law protects the downstream water users on the Logan River System. These downstream users have such small ditches and small water company organizations, however, that transfer of water is prevented. The most complicated distribution problem on the Logan River System is on the eighth ward diversion. About 12 separate companies claim some sort of right from this one division point (2, 1963, p. 6).

This complex system of individual rights has lead to the construction of parallel canals. This results in inefficiency.

> Responsibility for the main canal system is undefined, and the physical condition of the system is very poor. The water users in this system would improve their problems if they were to consolidate all rights into one company and adopt modern and competent management methods. The present system is inefficient and could result in an impairment of legal rights. (2, 1963, p. 6)

The third party effects are very great in small irrigation companies and this situation also causes restrictions to transfer because of possible legal entanglements. No exchanges have been made among these downstream companies which seems to indicate that they either have more water than they need, and thus no need of transfer, or that the physical and legal complications of transfer are such that it's not worth the effort.

While much emphasis has been placed on "reasonable" or "beneficial" use, the legal definition may not have the same meaning as the economic concept. What appears to an economist as an ideal allocation of water to certain uses, might not correspond with the legal restrictions of

water law. For this reason economists should play an increasing role in modifying the law and help to modify over-ruling former precedents which are undesirable (32, p. 2).

Rental Prices

The rental prices of water on the Logan, Hyde Park and Smithfield Canal Company have been $7 per share as shown in Table 5. One share allows a farmer 7.7 acre-feet during an average water year. This is generally enough for two acres of land. Water on this canal is measured by actual flow meters at the head of each user's pipe lines. They can use the water any time they desire but the number of shares held determines the total amount of water they can use during the year.

The Logan Northern Irrigation Company water is rented for $6 a share. The water is regulated by allowing each farmer a 3 cubic-foot-per-second stream for one-half hour every 2 weeks for each water share he owns. A farmer who has 48 shares of stock is entitled to a stream of water 24 hours every 14 days. If he didn't complete his irrigation during this time, he doesn't get another turn for 14 days. The time per share is cut down as the stream flow of Logan River decreases according to the Kimball Decree (see Table 4).

Irrigators on the Benson Irrigation Company, the Northwest Field, and the North Field generally have difficulty regulating water flows; so the watermasters have allowed users water until they have finished irrigating. With this type of an arrangement, they normally have sufficient for their needs. As a result, very little water is rented. If any additional is needed, it can be obtained merely by paying the operation and maintenance charge. This generally costs about $1.50 to $2.50 per share. This must be done at the beginning of the irrigation season, however.

Table 5. Logan River water sales, 1962-1966

	Logan, Hyde Park & Smithfield	Logan No. Irr. Co.	Logan Hollow Canal Co.	Providence Logan Canal	Logan Island Irr. Co.	7th Ward Irr. Co.	Hyde Park Logan North Field	Logan Northwest Field	Benson Irr. Co.	Southwest Field	Providence Pioneer
Acre foot/acre	4.317	4.69	4.09	4.21	10.7	6.28	1.98	2.73	4.12	1.66	4.15
Shares	2,000	3,279	376	400	1,400	155	3,100	2,400	1,000	850	206
Acre foot/share	7.77	5.297	1.74	4.21	2.74	4.05	1.79	2.73	4.12	1.66	4.03
Rental price/ share $	7.00	6.00	3.00	5.00	2.50	1.50	rental	none	none	none	2.00
O & M/share $	3.00	4.00	3.00	5.00	2.50	1.50	1.30	1.00	2.00	1.00	2.00
Annual rental cost/ acre foot $	.91	1.13	1.72	1.18	.91	.27	-	-	-	-	.50
Rental price over O & M	4.00	2.00	-	-	-	-	-	-	-	-	-
O & M cost/ acre feet	.39	.76	1.72	1.18	.91	.27	.76	.27	.48	.55	.50
Selling price/ share	550.00	150.00	25.00	25.00	10.00	10.00	5.00	5.00	no sales	no sales	10.00
Selling price/ acre feet	70.78	28.31	14.36	5.93	3.65	2.46	2.79	1.83	no sales	no sales	2.48
Description of irrigation areas	mostly farming	mostly farming	city lots	mostly city lots	city lots	mostly city lots	mostly farming	mostly farming	mostly farming	mostly farming	mostly city lots
Description of land area	high bench land	bench land	river bottom	low land	river bottom	low land	low;lot of sub-water	low; lot of sub-water	low;lot of sub-water	low;lot of sub-water	low;many springs & sub-water

Table 5a. Logan River water used in acre-feet for 1962-1966

	Logan Hyde Park & Smith-field	Logan No. Irr. Co.	Logan Hollow Canal Co.	Provi-dence Logan Canal	Logan Island Irr. Co.	7th Ward Irr. Co.k	Hyde Park Logan North Field	Logan North-west Field	Benson Irr. Co.	South-west Field	Provi-dence Pioneer
1962 a	14,844	19,673	576	1,445	3,871	513	6,497	7,718	5,514	1,162	722
1963 a	16,119	15,740	489	1,794	3,513	400	5,745	6,708	3,685	1,021	688
1964 a	13,460	15,665	706	1,760	3,976	570	5,743	5,980	4,112	1,041	775
1965 a	17,064	19,543	890	1,925	4,171	573	6,623	6,469	4,055	1,226	983
1966 a	15,584	16,224	611	1,504	3,675	1,083	3,114	5,928	3,235	2,634	988
Total	77,071	86,845	3,262	8,428	19,206	3,139	27,722	32,803	20,401	7,084	4,156
Average acre-feet/year	15,514	17,369	654	1,685	3,841	628	5,544	6,560	4,120	1,416	831
Acres irrigated	3,600	3,700	160	400	356	100	2,800	2,400	1,000	850	200

Source: a (2)

The first row in Table 5 indicates that irrigation companies are in reality getting about the same amount of water per acre even if they serve low lands and can utilize the return flow from other companies, whether they need it or not.

The Hyde Park, Logan North Field, Northwest Field, and Southwest Field Companies appear to be exceptions to this but irrigation officials of these companies indicate they receive more water than these figures indicate. Much more unmeasured water flows into these streams downstream from the measuring devices.

Sale Prices

Water shares have recently been sold on the Logan, Hyde Park, and Smithfield Canal for $550 per share as indicated in Table 5. These shares were sold to the city of North Logan, the city of Logan, Utah State University, and the golf course by farmers who sold their land for housing developments. A few shares have been sold to owners of city lots in North Logan too large to sprinkle with city water.

Logan City purchased water to irrigate the cemetery and some of its parks and playgrounds. Utah State University also purchased extra water from irrigators of the Logan, Hyde Park, and Smithfield Canal to irrigate the Campus.

The present rental price of $7 per share for agricultural use does not reflect the $550 per share valuation. To be consistent with this sale price, the water should rent at $27.50 per share at 5 percent. Inasmuch as a share represents about 7.77 acre-feet of water, the rental value should be equivalent to $3.54 per acre-foot.

Water shares on the Logan Northern Irrigation Company have sold for $150 to farmers.

Water sales on the lower canals, the Benson Irrigation Company, Northwest Field, etc., have been very few. This can be attributed to legal restrictions on transfer. Because water is usually plentiful for these canal companies, sales are few. Prices per share vary from $5 to $25.

The University has an alternative of using Logan City water or irrigation water from Logan, Hyde Park, and Smithfield Canal to irrigate the Campus. At the range in pricing from 11 cents to 8 cents per thousand gallons, the cost of water to the University would range from $26 to $32 an acre-foot if Logan City water were used. At the present time they use all the water which their shares permit from the canal and then supplement it with Logan City water.

The fact that upper canal water is valued so much higher shows the rigidity of the Kimball decree. The legal machinery involved in transfer prohibits buying water out of the lower canals where the supply is plentiful, crop requirements are low, and the marginal value as reflected in rentals is low, and transferring it to the Logan, Hyde Park, and Smithfield canal. This is clearly shown when Table 2 and 4 are compared. Very little transfer of water has been made among canal companies during the past 41 years. Logan, Hyde Park, and Smithfield Canal flow has increased only 3 cubic feet per second since 1922 when Logan River flow is 120 cubic feet per second. Many canals haven't changed any. Another reason for no transfers is that all members of the canal company must agree before any water can be transferred.

As an alternative approach to evaluate water, residual imputation will be used next. The basic input and output data will be discussed and evaluated. The value remaining after all factors except water have been paid out of revenues will be attributed to water. This will permit

a comparison between the market pricing and residual imputation. Both methods or approaches will then be discussed.

Basic Input-Output Data

Farm management surveys were conducted by the Bureau of Reclamation on a random sample pattern to determine the type of farming, type of soil, size of farm, crop yields, and irrigation practices for each crop. A total of 44 farms were included in the Cache County survey.

Information obtained from the Soil Conservation Service, Agriculture Stabilization and Conservation Service, County Assessor and the local irrigation companies, as shown in Table 6, indicated that the average size farm was 120 acres, of which 80 acres are irrigated (4, p. 15).

Table 6. Size of farm as determined from various sources

	Soil Conservation Service	Agriculture Stabilization and Conservation	Irrigation companies stock list	County Assessor	Average
No. of owners	37	150	196		
Total acreage	123	124		117	120
Irrigated	74	93	79	74	80
Other	49	31		43	40

Source: (4, p. 15).

Type of soil

Class II land was predominant, and very little Class I land exists in the valley. Therefore, Class II was used in the analysis. Most farms

are not completely one-class land; on one farm all three classes might be represented.

Type of farms and yields

The farm survey showed that most irrigated lands were on grade A and grade C dairy farms or used for combination dairy and cash crops.

The yields and the water required per acre on Class II lands in Cache County are indicated in Table 7 below.

Table 7. Yield per acre and water required per acre, Cache County, Utah

Crop	Yield (a)	Unit	Water required/ acre in acre-feet (b)
Alfalfa	4	ton	4.24
Barley	60	bushel	2.21
Wheat	50	bushel	2.21
Sugar beets	15	ton	3.37
Peas	1.6	ton	2.50
Canning corn	6	ton	3.32
Rotation pasture	7.5	AUM	4.00

Source: a (4, p. 148) b (7).

Prices received by farmers

The prices used in this study were representative of the level of prices which farmers might be expected to receive over a period of years. This assumes a continued high level of employment, continued population, and economic growth and a stable general price level. Table 8 indicates long term projections as to average prices in Cache County.

Table 8. Prices of various farm produced commodities

Crop	Unit	Projected Price	Source of price data
Alfalfa--baled	ton	$21.00	USDA State Price Data f. Utah
Barley	bushel	1.22	" " " " "
Wheat	bushel	1.60	" " " " "
Rotation pasture	AUM	5.00	Based on feed equivalent of alfalfa
Sugar beets	ton	13.00	Utah-Idaho Sugar Company
Canning corn	ton	21.33	California Packing Corporation
Canning peas	ton	83.00	" " "

Source: (4, p. 29).

Variable Costs

Labor and management

The wage rate for hired labor and family labor including the operator was $1 per hour. The total labor for each crop was computed. The budget also included 10 percent for return to management based on net income.

Seed costs

The following figures show the amount of seed, the interval of seeding, and the per acre cost of seed.

Table 9. The seeding rates for principal crops

Crop	Unit	Amount / acre	Unit price	Seeding interval	Annual cost
Alfalfa	lb.	10	$ .39	4 years	$ .97
Barley	bushel	2.1		annually	farm-produced
Wheat	bushel	1.7		annually	farm-produced
Pasture	lb.	17	.46	5 years	1.56
Sugar beets	lb.	5	.70	annually	3.50
Canning peas	bushel	5	4.40	annually	22.00
Canning corn	lb.	9	.48	annually	4.32

Source: (4, p. 81).

Fertilizer

The following table indicates application of commercial fertilizer used on the crops.

Table 10. Rates of commercial fertilizer used, percent of crop covered annually, and price per unit

Crop	Available lbs. applied/acre N	P_2O_5 (a)	Percent of crop covered annually (a)	Price of fertilizer N	P_2O_5
Alfalfa		50	25	12¢ lb	
Pasture	50		50		9¢ lb.
Sugar beets	60	40	100		
Corn	40				

Source: (4, p. 80).

Baling twine

The cost of baling twine was 8 cents a bale. Farmers estimate that one bale of twine will tie 450 bales of hay weighing approximately 65 pounds per bale or 14.5 tons for one bale of twine.

Fuel, oil and grease

The price of gasoline is currently 35 cents per gallon. Farmers in this area buy most of their gasoline at a 3 cent discount. In addition they can receive a rebate of 4 cents per gallon for Federal tax. Because many farmers do not keep adequate records, some of them do not get this rebate of tax back, so 29 cents a gallon was used. The cost of oil and grease for farm equipment was one-sixth of the cost of fuel (4, p. 49).

Auto and truck expenses were based on operating costs. The automobiles were charged only for farm use, only at 2.4 cents per mile and driven 8,000 miles. The truck operating expense was 3.4 cents per mile and they were driven an estimated 2,000 miles.

Miscellaneous expenses were assumed to be 2 percent of the total crop costs per acre.

Fixed Costs

Taxes are assessed on land at about 20 percent of its market value and machinery 35 percent of its value. The mill levy used was 53.6.

Depreciation on buildings and equipment includes sufficient for repair and maintenance of the same. The more specialized equipment such as the combines and sugar beet harvesting and corn harvesting equipment are owned only on larger farms or owned jointly by two or more farm operators. Most small farmers hire custom operators to bale their hay, combine their grain, and harvest their beets.

The annual expense for machinery and equipment consists of depreciation, repairs, shelter, operating costs, and maintenance. Straight line depreciation on original cost less salvage value were used in this analysis.

Interest on land was figured on total amount of investment in land. Class II land was valued at $141 per acre. This was only the normal land value as reflected on a dry land equivalent; development cost needed for irrigation was also included. This may not, however, reflect the market value of the land but represents the initial cost of the land plus any development costs incurred.

Interests on machinery and equipment were calculated on inventory value. As some of the original value had been depreciated out, 60

percent of new value was the figure used in establishing a base for which interest was figured.

Four different interest rates were used in arriving at the interest on investment of land and equipment. As interest on investment plays a major role in determining water value, the one which is chosen should be carefully studied for this purpose. A range of between 3 percent and 7 percent was chosen.

The Residual Value of Water

The index of abbreviations used in the formulas to follow are indicated below:

RV_i - residual value of water/acre-foot for the ith crop.

RV_f - residual value of water/acre-foot for a given farm.

Oi - operating cost of the ith crop.

Ii - interest cost of the ith crop.

Fi - fixed costs of the ith crop.

Yi - yield per acre of the ith crop.

Pi - price per unit of the ith crop.

Ai - number of acres of the ith crop.

Wi - water used per acre for the ith crop.

M - management return of 10 percent.

NI - net income for the ith crop.

Ci - change in farm cost of the ith crop.

Ri' - change in return $(Yi' \cdot Pi') - (Yi - Pi)$

Yi' - change in yield

Pi' - change in price

RV_i' - new adjusted residual value of water per acre-foot for the ith crop

RV_f' - new adjusted value of water per acre-foot for given farm

The residual value of water per crop-acre (RV_i) would reflect the income value remaining after all the fixed and variable expenses except for water have been paid their market value equivalent. Since labor was only given $1 per hour, 10 percent of net receipts was imputed to management. To get water value on a per acre-foot basis, the total acre-feet of water used would be divided into the total crop water value. The method used to figure net income and residual value of water per crop follows.

$$NI = (Yi \cdot Pi) - (Oi + Fi + Ii)$$

$$RV_i = \frac{NI - (NI \cdot M)}{Wi}$$

For example, the residual value for barley per acre, as reflected in Table 11 by using 5 percent interest on investment with the above formula, is as follows:

Y = 60 bushels	O = $31.07
P = $1.22	F = $24.42
W = 2.21	I = $18.22

$$NI = (60 \cdot 1.22) - (31.07 + 24.42 + 18.22) = \$17.49$$

$$RV_i = \frac{17.49 - (17.49 \cdot .10)}{2.21} = \$7.12/\text{acre}$$

To calculate the value of water for the 85 acre farm as shown in Table 12 the formula below is used.

$$RV_f = \frac{\sum_{i=1}^{n} (RV_i \cdot Ai)}{\sum_{i=1}^{n} (Wi \cdot Ai)}$$

$$RV_f = \frac{\$1575.54}{283} = \$5.56$$

Effect of changing costs

There may be changes in costs which are not shown in this thesis.

Table 11. Net income (NI) and residual value of water (RV_1) using 5 percent interest on investment for an 85-acre farm in Cache County

Acres:	22	11	12.5	18	6	15.5
Crops:	Alfalfa	Wheat	Barley	Beets	Peas	Pasture
Total expense	$67.85	$49.63	$55.49	$117.96	$68.13	$21.97
plus 5% interest	20.53	18.22	18.22	19.93	16.75	15.72
Total expense	$88.38	$67.85	$73.71	$137.89	$84.88	$37.69
Yield	4 ton	50 bu.	60 bu.	15 ton	1.6 ton	7.5 AUM
Price/unit[a]	21/ton	1.60/bu.	1.22/bu.	13/ton	83/ton	5/AUM
Total income	$84.00	$98.00	$91.20	$195.00	$132.00	$37.50
Total net income	$-4.38	$30.15	$17.49	$57.11	$ 47.12	$ -.19
less 10% mgt.		3.02	1.75	5.71	4.71	
Net income/acre	$-4.38	$27.13	$15.74	$51.40	$ 42.41	$ -.19
Total income/crop	$-96.36	$298.43	$196.75	$925.20	$254.46	$-2.94
Amount of water/acre	4.24	2.21	2.21	3.37	2.50	4.00
Acre feet of water/crop	93.28	24.31	27.62	60.66	15.00	62.00
Value/acre foot used/acre (RV_1)	$-1.03	$12.27	$ 7.12	$15.25	$16.96	$-.05

[a] Price of wheat and barley also includes straw at $18.00 per acre.

Table 12. Summary of residual water value calculations for three farm sizes with class II soil at 5 percent interest and return in Cache County

	No. of acres	(RV_i . Ai) Total net returns/ acre	(Wi.Ai) Total water	(Wi) Water/ acre	(RV_i) Returns/ acre-foot
72-acre					
Alfalfa	19.5	-11.24	82.68	4.24	-2.65
Barley	13.5	18.18	29.83	2.21	8.23
Wheat	3.0	24.33	6.63	2.21	11.01
Beets	13.0	47.88	43.80	3.37	14.21
Corn	6.0	49.89	19.90	3.32	15.02
Pasture	17.0	-3.53	68.00	4.00	-.88
Total	72.0	(a)961.00	(b)250.00	3.47	
Residual farm value (RV_f)					3.84
85-acre					
Alfalfa	22.0	-4.38	93.28	4.24	-1.03
Wheat	11.0	27.13	24.31	2.21	12.27
Barley	12.5	15.74	27.62	2.21	7.12
Sugar Beets	18.0	51.40	60.66	3.37	15.25
Peas	6.0	42.41	15.00	2.50	16.96
Pasture	15.5	-.19	62.00	4.00	-.05
Total	85.0	(a)1,575.54	(b)283.00	3.33	
Residual farm value (RV_f)					5.56
125-acre					
Alfalfa	32	13.27	135.68	4.24	3.12
Wheat	17	38.78	37.57	2.21	17.58
Barley	22	31.10	48.62	2.21	14.07
Sugar Beets	19	73.80	64.03	3.37	21.89
Peas	4	51.82	10.00	2.50	20.72
Pasture	31	1.18	122.00	4.00	.29
Total	125	(a)3,413.57	(b)418.00	3.34	
Residual farm value (RV_f)					8.16

a = Σ (RV_i . Ai)

b = Σ (Wi . Ai)

Cost changes may affect one crop only or all crops in case labor costs should increase. This was used in the formula in affecting cost changes.

$$RV_i' = RV_i + \frac{(Ci - Ci \cdot M)}{Wi}$$

A change in the price of labor from $1.00 to $1.25 an hour would have the following effect on the residual value of water for the farm (RV_f). Total labor used was 1,982 hours and 283 acre-feet of water on the 85-acre farm. A 25 cent change in the price of labor would cause an added expense of $495.50. Using the formula described below and the RV_f of $5.56 from Table 12, the change in labor price would affect water value as follows:

$$RV_f' = RV_f - \frac{\sum_{i=1}^{n} (Ri - (Ri \cdot M))Ai}{\sum_{i=1}^{n} (Wi \cdot Ai)}$$

$$RV_f' = \$5.56 - \frac{(\$495.50 - (\$495.50 \cdot .10))}{283}$$

$$= \$5.56 - \$1.57$$

$$RV_f' = \$3.99$$

Effect of income changes

Change in income can be the result of yield change or a shift in the price received. The formula, however, assumes only minor changes which would not affect costs. In extreme cases, an estimate would have to be made of the increase or the decrease in costs and allowance adjusted for the change in labor required and other minor expenses.

An example of a change in yield of barley of an additional 10 bushel per acre at $1.22 a bushel would bring $12.20 additional income per acre. This would affect the residual value of water on barley on

an 85-acre farm from what is shown on Table 11 as follows:

$$Ri = (10 \text{ bu.} \cdot \$1.22) = \$12.20 \quad RV_i = \$7.12$$

$$RV_i' = RV_i + \frac{(Ri - (Ri \cdot M))}{Wi}$$

$$RV_i' = RV_i + \frac{(12.20 - (12.20 \cdot .10))}{2.21}$$

$$= \$7.12 + \$4.96 = \$12.08 = RV_i'$$

Table 13 shows the summary of the budgets, two of which are in the Appendix, Tables 18 through 27, for three different sized farms. The residual returns per acre for each crop (RV_i) are shown for each interest rates at 3, 4, 5, and 7 percent. Residual value per farm (RV_f) are given for each farm size.

The residual value of water for the various crops (RV_i), Table 13, range from $-4.72 an acre-foot for alfalfa on the 72-acre farm at 7 percent interest on investment to $23.88 an acre-foot for beets on 124.5 acres at 3 percent interest on investment. At 5 percent the values range from $-2.65 on alfalfa to $21.89 on beets.

It should be noted that individual crop residual water values (RV_i) tend to be biased. The normal crop rotation practiced by Cache County farmers favors alfalfa because it is primarily used to restore fertility and usually remains at least 3 years before it is plowed under. Row crops which follow receive the benefit; therefore, the value of water for alfalfa may be biased downward and the value of water for sugar beets may be biased upward.

The average residual value of water for the whole farm is a more meaningful measurement. These values ranged from $1.30 on the 72-acre farm with 3 percent interest on investment to $9.90 at 7 percent interest with 124.5-acre farm. At 5 percent the value ranged from

Table 13. Residual water values per acre-foot by crop (RV_i) and farm (RV_f) size at various rates of interest on fixed investment on Class II land in Cache County

Crop	Acres	Residual returns/acre-foot for crop (RV_i) and farm (RV_f) 3%	4%	5%	7%
72-acre					
Alfalfa	19.5	$ -.57	$-1.38	$-2.65	$-4.72
Wheat	3.0	13.65	12.33	11.01	8.36
Barley	13.5	10.86	9.54	8.23	5.57
Sugar beets	13.0	16.80	15.51	14.21	11.60
Corn (canning)	6.0	16.75	15.89	15.02	13.29
Pasture	17.0	.38	-.25	-.88	-4.07
Residual value for farm (RV_f)		5.84		3.84	1.30
85-acre					
Alfalfa	22.0	.82	-.06	-1.03	-2.97
Wheat	11.0	15.24	12.51	12.27	9.31
Barley	12.5	10.04	8.61	7.12	4.58
Beets	18.0	17.38	16.31	15.25	13.12
Peas	6.0	19.37	18.16	16.96	14.54
Pasture	13.5	1.37	.66	-.05	-1.62
Residual value for farm (RV_f)		7.61	6.60	5.56	3.45
124.5 acre					
Alfalfa	32.0	4.64	3.88	3.12	1.60
Wheat	17.0	20.18	18.96	17.54	14.91
Barley	22.0	16.70	15.38	14.17	11.43
Beets	19.0	23.88	22.89	21.89	19.91
Peas	4.0	22.77	21.52	20.72	18.68
Pasture	30.5	1.51	.90	.29	-1.02
Residual value for farm (RV_f)		9.90	9.03	8.16	6.39

$3.84 with the 72-acre farm to $8.16 with the 124.5-acre farm. It is obvious that one of the necessary conditions mentioned in the theoretical section, of constant costs, may not appear to be fulfilled. The residual returns show as farm size increases, residual rents also increase.

The average fixed cost ranged from $17.05 per acre on the 124.5-acre farm to $30 an acre on the 72-acre farm. All this indicates is that fixed factors of production are being given income that would otherwise accrue to water. The procedure is limited, however, because in reality water may not have to give way to the fixed factors at all. Water is in just as good position to claim its rightful returns as any other factor of production. The fault is in the method which assumes that the water receives only what is left over after the other factors have been paid.

Another limitation is that to get a good indication of value and price, both demand and supply factors have to be at work. This is the case in a perfectly competitive market situation, but in the residual method, only demand factors are at work. There is no way that variations in water supply can influence the residual returns to water.

The smaller farm seems to be overinvested. This increasing fixed cost would explain why water values tend to increase with size of farm.

Table 14 shows the basic operating and fixed expenses for the farm by crop on a per acre basis. Also, the total expense for each item of expense is shown in the far right column. This table also shows the farm investment per acre and the interest charges from 3 percent to 7 percent on an 85-acre farm. Appendix Tables 18 and 23 show the same basic data on 72-acres and 124.5-acre farms, respectively.

Tables 15 through 17 show the residual value of water (RV_1) using 3 percent, 4 percent, and 7 percent, respectively, for an 85-acre farm.

Table 14. The operating and fixed expenses of an 85-acre farm in the Cache County area

Acres:	22	11	12.5	18	6	15.5	85
Crops:	Alfalfa	Wheat	Barley	Beets	Peas	Pasture	Total for farm
Operating exp.							
Misc. labor	$ 2.89	$ 2.89	$ 2.89	$ 2.89	$ 2.89	$ 1.35	$ 241.76
Labor	16.70	9.50	9.50	52.30	16.60	7.00	1,740.15
Seed	.97	used own seed		3.50	20.00	1.56	240.52
Fertilizer	1.42	--	4.74	10.92	--	1.84	315.57
Spraying	.70	--	1.00	--	1.50	--	36.90
Twine	2.47	.40	.40	--	--	--	63.74
Fuel and oil	3.45	3.10	3.10	8.12	3.35	.71	326.01
Truck & auto exp.	1.98	1.98	1.98	1.98	1.98	.92	151.87
Harvesting (custom)	--	6.00	6.00	--	--	--	141.00
Misc. 2% exp.	1.70	1.34	1.46	2.54	1.76	.80	139.07
Total operating expense	$32.28	$25.21	$31.07	$83.36	$50.08	$14.18	$3,396.59
Fixed exp.							
Taxes: land & equip.	$ 7.25	$ 6.00	$ 6.00	$ 6.86	$ 1.80	$ 1.00	$ 450.28
Insurance: bldg. & equip.	.73	.94	.94	.60	.40	.40	57.57
Depree., repair on equip.	25.47	14.23	14.23	25.02	12.60	4.27	1,486.89
Depree., repair on bldgs.	1.70	2.83	2.83	1.70	2.83	1.70	177.83
Utilities	.42	.42	.42	.42	.42	.42	35.70
Total fixed expenses	$35.57	$24.42	$24.42	$34.60	$18.05	$ 7.79	$2,208.27
Total expenses (interest not incl.)	$67.85	$49.63	$55.49	$117.96	$68.13	$21.97	$5,604.86
Total farm inv. per acre	$410.60	$364.40	$364.40	$398.60	$314.40	$335.00	
Interest @ 3%	12.31	10.93	10.93	11.94	10.05	9.43	
4%	16.42	14.57	14.57	15.94	13.40	12.58	
5%	20.53	18.22	18.22	19.93	16.75	15.72	
7%	28.74	25.50	25.50	27.90	23.46	22.02	

Table 15. Net income (NI) and residual value of water (RV_1) using 3 percent interest on investment for an 85-acre farm in Cache County

Acres:	22	11	12.5	18	6	15.5
Crops:	Alfalfa	Wheat	Barley	Beets	Peas	Pasture
Total expense	$ 67.85	$ 49.63	$ 55.49	$117.96	$ 68.13	$21.97
less 3% interest	12.31	10.93	10.93	11.94	10.05	9.43
Total expense	$ 80.16	$ 60.56	$ 66.42	$129.90	$ 78.18	$ 31.40
Yield	4 ton	50 bu.	60 bu.	15 ton	1.6 ton	7.5 AUM
Price/unit*	21/ton	1.60/bu.	1.22/bu.	13/ton	83/ton	5/AUM
Total income	$ 84.00	$ 98.00	$ 91.20	$195.00	$132.80	$ 37.50
Total net income	$ 3.84	$ 37.44	$ 24.78	$ 65.10	$ 53.82	$ 6.10
less 10% mgt.	.38	3.74	2.48	6.51	5.38	.61
Net income/ac.	$ 3.46	$ 33.70	$ 22.20	$ 58.59	$ 48.44	$ 5.49
Total income/crop	$ 76.12	$370.70	$277.50	$1,054.62	$290.64	$ 84.10
Amount of water/acre	4.24	2.21	2.21	3.37	2.50	4.00
Acre-feet of water/crop	93.28	24.31	27.62	60.66	15.00	62.00
Value/acre-foot used/acre	$ .82	$ 15.24	$ 10.04	$ 17.38	$ 19.37	$ 1.37

* Price of wheat and barley also includes straw at $18.00 per acre.

The value of water on this farm at 3 percent interest is as follows:

$$RV_f = \frac{\sum_{i=1}^{n} (RV_i \cdot Ai)}{\sum_{i=1}^{n} (Wi \cdot Ai)}$$

$$RV_f = \frac{\$2,145.68}{283} = \$7.61$$

Table 16. Net income (NI) and residual value of water (RV_1) using 4 percent interest on investment for an 85-acre farm in Cache County

Acres:	22	11	12.5	18	6	15.5
Crops:	Alfalfa	Wheat	Barley	Beets	Peas	Pasture
Total expense	$ 67.85	$49.63	$ 55.49	$117.96	$ 68.13	$ 21.97
less 4% interest	16.42	11.57	14.57	15.94	13.40	12.58
Total expense	$ 84.27	$64.20	$ 70.06	$ 133.90	$ 81.53	$ 34.55
Yield	4 ton	50 bu.	60 bu.	15 ton	1.6 ton	7.5 AUM
Price/unit*	21/ton	1.60/bu.	1.22/bu.	13/ton	83/ton	5/AUM
Total income	$ 84.00	$ 98.00	$ 91.20	$195.00	$132.00	$ 37.50
Total net income	$ -.27	$ 33.42	$237.88	$989.92	$272.52	$ 41.08
less 10% mgt.		3.38	2.11	6.11	5.05	.30
Net income/acre	$ -.27	$ 30.42	$ 19.03	$ 54.99	$ 45.42	$ 2.65
Total income/crop	$ -5.94	$334.62	$237.88	$989.92	$272.52	$ 41.08
Amount of water/acre	4.24	2.21	2.21	3.37	2.50	4.00
Acre-feet of water/crop	93.28	24.31	27.62	60.66	15.00	62.00
Value/acre-foot used/acre	$ -.06	$ 12.51	$ 8.61	$ 16.31	$ 18.16	$ .66

* Price of wheat and barley also includes straw at $18 per acre.

$$RV_1 = \frac{\$1869}{283}$$

$$RV_1 = \$6.60$$

Table 17. Net income (NI) and residual value of water (RV_1) using 7 percent interest on investment for an 85-acre farm in Cache County

Acres:	22	11	12.5	18	6	15.5
Crops:	Alfalfa	Wheat	Barley	Beets	Peas	Pasture
Total expense	$ 67.85	$ 49.63	$ 55.49	$117.96	$ 68.13	$ 21.97
less 7% interest	28.74	25.50	25.50	27.90	23.46	22.02
Total expense	$ 96.59	$ 75.13	$ 80.99	$145.86	$ 91.59	$ 43.99
Yield	4 ton	50 bu.	60 bu.	15 ton	1.6 ton	7.5 AUM
Price/unit*	21/ton	1.60/bu.	1.22/bu.	13/ton	83/ton	5/AUM
Total income	$ 84.00	$ 98.00	$ 91.20	$195.00	$132.00	$ 37.50
Total net income	$-12.59	$ 22.87	$10.21	$ 49.14	$ 40.41	$ -6.49
less 10% mgt.		2.29	1.02	4.91	4.04	
Net income/acre	$-12.59	$ 20.58	$ 9.19	$ 44.23	$ 36.37	$-100.59
Amount of water/acre	4.24	2.21	2.21	3.37	2.50	4.00
Acre-feet of water/crop	93.28	24.31	27.62	60.66	15.00	62.00
Value/acre-foot used/acre	$ -2.97	$ 9.31	$ 4.58	$13.12	$ 14.54	$ -1.62

* Price of wheat and barley also includes straw at $18.00 per acre.

$$RV_1 = \frac{\$978.05}{283}$$

$$RV_1 = \$3.45$$

The Appendix Tables 19 to 22 show the residual values for a 72-acre farm and Tables 24 to 27 show the same for a 124.5 acre farm. The summary of these tables is shown in Table 13 mentioned previously.

A comparison of values between the residual approach and the water market is informative.

The agriculture rental market exists primarily with the Logan, Hyde Park, and Smithfield Canal and Logan Northern Irrigation Company. The rents per acre-foot are 91 cents and $1.13, respectively, based on the average water used between 1962 and 1966. The lower canals have not reported any water rental for agriculture.

Under an administered price of $4.00 per acre-foot, exchanges can be made between the city of Logan and the Water Users. Movement of water, under this agreement, has been from the Water Users to the city of Logan. Under these conditions farmers evidently value water less than $4.00 an acre-foot.

The sale price of shares on the Logan, Hyde Park and Smithfield Canal of $550.00 would represent $70.78 per acre-foot (Table 5) or a rental value at 5 percent of $3.54 per acre-foot. A factor contributing to the high price of water on the Logan, Hyde Park and Smithfield Canal is the purchase by Utah State University of many shares to provide water for sprinkling the Campus lawns. The city of Logan also has bought shares to irrigate the cemetery. In addition, the golf course is using water and the city of North Logan has purchased extra water. The area under this canal is irrigated primarily by gravity-flow sprinkling which is a cheaper alternative water source for these municipalities than using culinary water. Small lot owners are also able to buy small half-shares for the cities to irrigate their lots. Irrigators on the Logan, Hyde

Park and Smithfield as well as the Logan Northern Canals can rent extra water at a much lower price than water shares can be purchased. Since the rental price for water is much cheaper than the sale price, the farmers have not purchased any appreciable amount of water on the Logan, Hyde Park, and Smithfield Canal or the Logan Northern Canal. Extra water needed in late summer and fall can be purchased for $4.00 per acre-foot from the city. Irrigators of the Northwest Field have sold water for $5.00 a share or $1.83 per acre-foot, but no annual rentals occurred.

With the given data, residual values of water on the 72-acre farm range from $1.30 to $5.84 per acre-foot using 7 percent and 3 percent interest on investment. Using the same interest values on the 85-acre farm values were $3.45 to $7.61 and for the 120-acre farm $6.39 to $9.90.

Farm size has increased in the past and can be expected to continue. At the present time in Cache County the 85-acre farm may be most representative. Assuming an interest rate between 5 percent and 7 percent, water values would range between $3.45 and $5.56. As farm size approaches 124.5 acres, water values might be expected to be between $6.39 and $8.16 using 5 percent and 7 percent interest on investment.

SUMMARY AND CONCLUSIONS

The city of Logan generally directed water distribution until the early 1900's when this authority was transferred by the Legislature to the state engineer. The state engineer demanded that water distribution be based upon established water rights. As a result, water users in the State were ordered to submit their claims to any stream in order to establish priority. This caused considerable concern and before many water rights were finally settled, litigation resulted. On the Logan River, the Call Decree settled the first major dispute which involved the whole River. This decree divided the water on the basis of customary use and the amount of land irrigated under the respective canals.

In 1922, the Kimball Decree settled a second major dispute which involved the whole Bear River System. This decree also affected the Logan River because it was a major tributary to the Bear River. The Utah Power and Light was trying to expand and needed to know its bounds and limitations of water use for power. This dispute lasted many years because of the large task which involved the rights on the many streams. The Kimball Decree used the basic decisions of the Call Decree and only changed the dates of the irrigation season. This decree allotted water to all the canal companies according to the number of acres under each canal. Allocation of that water was left to the respective companies. The distribution of water within these companies was left to the various watermasters as the companies directed. Water may be efficiently allocated within these various irrigation companies within their given

water supply. However, because of the rigidities of the Kimball Decree, which restricts transfer between companies, misallocation is evident on the Logan River Distribution System. This is obvious when comparing sales prices of similar units of water from the upper canal and the Benson, Northwest Field and other lower canals. Also, when the Kimball Decree of 1922 (Table 2) is compared with the revised schedule of water allocation drawn up by the courts in 1963, it is found that very little inter-company change has been made in 41 years.

As Logan grew so did its use of water. The city expanded its water mains and enlarged the main pipeline from DeWitt Springs without obtaining additional water rights. In 1959, the Logan River water users issued a complaint against the city for exceeding its decreed water rights. This action resulted in the appointment of a water commissioner responsible to the state engineer for division of water among the irrigators.

When city officials realized that the city couldn't legally obtain more water than their original decreed rights from DeWitt Springs, they authorized the drilling of four wells. The city then agreed to exchange water with Logan River water users. According to this agreement, the party using the most water would pay the other $4.00 per acre-foot for the amount over and above the city's 10 cubic-second-feet water-right. Under this agreement most of the water has been sold by the water users to the Logan City.

To find the residual value of water in Cache County, farm management surveys made by the Bureau of Reclamation were used. Market estimates of productivity and value (price) were subtracted from the operating and fixed expenses. The remainder was imputed to water. Return for water ranged from $1.30 per acre-foot using 7 percent interest on investment on

a 72-acre farm to $9.90 on a 124.5-acre farm using a 3 percent return on investment. The evidence of comparatively free transfer between Logan City and the farmers, and the movement of water from the farmers to the city strongly suggest that the marginal value of water is below $4.00 per acre-foot. If the $5.50 sales price on the shares purchased by the University and others were capitalized out on an annual basis, it would be $3.54 per acre-foot. This means that the farmers are willing to give up water at that price or that they value it at least this amount. It also means the University and others value this water at least this same amount.

If one assigns a little higher labor value, as pointed out with the 85-acre farm, the residual rent at 5 percent interest on investment is $3.99 per acre-foot. All these figures are reasonably comparable and might be sufficient evidence that the water value is at about this level. To chose a specific value of water and say that this is the value of water in Cache County would necessitate specific assumptions to be made. Were the market to operate freely, without transfer impediments, this would reflect the best estimate of the value of water.

Areas for Future Research

While many legal problems which prohibit transfer were alluded to, no attempt has been made in this thesis to answer them. Further study should be made in this area.

While all of the canals on the Logan River run through parts of Logan, a comparison of the cost of canal water as opposed to culinary water in irrigating city lots could be explored.

A study is now in progress by the state engineer to investigate

the possible effects of placing most of the water of the Logan River into an enlarged canal where the Logan, Hyde Park, and Smithfield Canal presently exists. It is thought that such a system would more efficiently use the available water. This study should provide many opportunities for economic appraisal.

As water competition will increase, these and many other areas of study should be explored to more effectively utilize the valuable and limited resource of water in the Cache County area.

LITERATURE CITED

1. Anderson, Raymond L. Organizational arrangements in water transfer. Proceedings of Committee on Economics of Water Resource Development of the Western Agriculture Economics Research Council, Portland, Oregon. December 1961, pp. 1-8.

2. Annual report of the Logan River Distribution System. Commissioners' report to Utah State Engineer, 1961-1967 (yearly).

3. Baumol, William J. Economic theory and operation analysis. Prentice-Hall, Inc., Englewood Cliffs, New Jersey. 1963. pp. 294-295.

4. Bureau of Reclamation. Bear River project. Feasibility report. Appendix F, Agriculture Economic and Financial Analysis. Unpublished report of United States Department of Interior. 1962.

5. Ciriacy-Wantrup, S. V. Some issues in water rights. Journal of Farm Economics 37. December 1955.

6. Clyde, George P. Water supply, water and its conservation. Utah State University Circular 138. January 1958.

7. Criddle, Wayne D., Karl Harris, and Lyman S. Willardson. Consumptive use and water requirements for Utah. Technical publication 8:12-20. 1962.

8. Fonnesbeck, Leon. Logan City light plant. The Caxton Printers, Caldwell, Idaho. 1944.

9. Fortier, Samuel. Irrigation in Cache: arrival of the pioneers and development of the present irrigation system. The Journal, (microfilm, Utah State University Library) July 20, 1897.

10. Fortier, Samuel. Water supply of Cache Valley. Utah Agricultural Experiment Station Bulletin 50. 1897.

11. Fullerton, Herbert H. Transfer restrictions and misallocation of irrigation water. Master's Thesis, Utah State University. 1965.

12. Gardner, B. Delworth. Transfer restrictions and misallocations in public range. Journal of Farm Economics 44:50-63. February 1962.

13. Gardner, B. Delworth and E. Boyd Wennergren. Productivity of water in agriculture. Unpublished paper for the Utah Power Board. 1967.

14. Gilgen, Venetta K. and Lydia T. Nyman. Miscellaneous papers on the history of North Logan, Utah, 1959-1966.

15. Hartman, L. M. and Norman Whittelsey. Marginal values of irrigation water. Colorado Agricultural Experiment Station, Fort Collins, Technical Bulletin 70.

16. Haws, Frank W. Hydrology of the Logan River. Unpublished Master's Thesis. 1967.

17. Heady, Earl O. Economics of agriculture production and resource use. Prentice-Hall, Inc., Englewood Cliffs, New Jersey. 1965.

18. Hirshleifer, Jack, James C. DeHaven, and Jerome W. Millman. Water supply economics, technology and policy. The University of Chicago Press, Chicago, Illinois. 1960.

19. Leftwich, Richard H. The price system and resource allocation. Holt, Rinehart and Winslow, New York. 1965. pp. 322-324.

20. Laws of the Territory of Utah, 1880.

21. Laws of Utah. 1903.

22. Laws of Utah, Chapter III, Section 100-3-1. 1939.

23. Logan City Corporation. Minutes of Logan City Council, Minute book unpublished, microfilm record in Utah State University Library, Logan. 1904-1912.

24. Logan City Corporation. Plaintiff vs. Logan, Hyde Park and Smithfield Canal Company, et. al., defendants. Notice of Appeal for a preliminary review of decision of the state engineer and complaint in support thereof. Civil Suit No. 9307, First District Court, Cache County, Utah, unpublished files in Office of County Clerk, Logan, Utah. 1961.

25. Logan and Richmond Irrigation Company. Unpublished minutes, Utah State University Library, Logan. 1878-1898.

26. Logan, Hyde Park and Smithfield Canal Company. Unpublished minutes, Utah State University Library, Logan. 1889-1904.

27. Logan Journal. Establishing water rights. Microfilm record on file at Utah State University Library, Logan. August 10, 1912.

28. Ricks, Joel E. and Everett L. Cooley. History of a valley. Cache Valley Centennial Commission, Logan, Utah. 1956.

29. Smith, Steven C. Legal and institutional controls in water allocation. Journal of Farm Economics 42. December 1960.

30. Stewart, Lynn T. An economic analysis of the Logan Cow Pasture Water Company. Master's Thesis, Utah State University, Logan. 1966.

31. Swendson, George L. Appropriation of water from the Logan River. Agriculture Experiment Station, Government Printing Office, Bulletin 124:307-308. 1903.

32. Trealease, Frank J. The concept of reasonable beneficial use in the law of surface streams. A paper presented to the Western Agriculture Economics Research Council Water Resource Committee, Berkeley, California. December 20, 1956.

33. Tullidge, Edward W. Tullidge's histories of Utah. Salt Lake City, Utah, Vol. 2. 1889.

34. Utah Code Annotated Title 73. Allen Smith Company. 1953.

35. Utah Power and Light Company. Plaintiff vs. Richmond Irrigation Company, et. al. Civil Case No. 1772, First District Court, Cache County, Utah. Unpublished Jobs of County Clerk, Logan, Utah. 1917-1922. (Kimball Decree) 1960, 1963.

APPENDIX

Table 18. The operating and fixed expenses of an 72-acre farm in Cache County, Utah

Acres:	19.5	13.5	3	13	6	17	72
Crops:	Alfalfa	Barley	Wheat	Beets	Corn	Pasture	Total for farm
Operating exp.							
Misc. labor	$ 3.12	$ 3.12	$ 3.12	$ 4.13	$ 2.13	$ 2.13	$ 215.00
Labor	10.50	9.40	9.40	50.70	14.30	7.00	1,340.75
Seed	.97	used own seed		3.50	4.32	1.56	116.85
Fertilizer	1.30			3.80	2.35	1.28	110.61
Spraying	.70	.72	.72		1.50		34.53
Twine	2.48	.38	.38				54.63
Fuel & oil	4.28	3.51	3.51	7.91	5.18	2.64	320.16
Truck & auto exp.	2.56	2.56	2.56	2.56	2.56	1.03	161.71
Harv.(custom)		6.00	6.00				99.00
Misc. 2% exp.	1.16	.92	.88	1.70	.84	.54	73.66
Total operating expense	$33.07	$26.61	$26.57	$74.30	$33.18	$16.36	$2,526.90
Fixed exp.							
Taxes: land & equip.	7.65	6.29	6.29	8.52	5.81	4.77	479.67
Insurance: bldg. & equip.	.88	.98	.98	.98	.98	.88	66.91
Deprec.,repair on equip.	29.77	17.48	17.48	31.84	15.75	4.47	1,453.34
Deprec.,repair on bldgs.	1.48	2.99	2.99	1.48	1.48	1.48	131.47
Utilities	.41	.41	.41	.41	.41	.41	29.52
Total fixed expenses	$40.19	$28.15	$28.15	$43.23	$24.43	$12.01	$2,160.91
Total expenses (interest not incl.)	$73.26	$54.76	$54.72	$117.53	$57.61	$28.37	$4,687.81
Total farm inv. per acre	$439.66	$325.00	$325.00	$484.67	$319.33	$253.33	
Interest @ 3%	13.19	9.75	9.75	14.54	9.58	7.60	
4%	17.59	13.00	13.00	19.38	12.77	10.13	
5%	21.98	16.25	16.25	24.27	15.96	12.66	
7%	30.77	22.75	22.75	33.72	22.35	25.43	

Table 19. Net income (NI) and residual value of water (RV_i) using 3 percent interest on investment for a 72-acre farm in Cache County

Acres:	19.5	13.5	3	13	6	17
Crops:	Alfalfa	Barley	Wheat	Beets	Corn	Pasture
Total expense	$73.26	$54.76	$54.72	$117.53	$57.61	$28.37
plus 3% interest	13.19	9.75	9.75	14.54	9.58	7.60
Total expense	86.45	64.51	64.47	132.07	67.19	35.97
Yield	4 ton	60 bu.	50 bu.	15 ton	6 ton	7.5 AUM
Price/unit[a]	21/ton	1.22 bu.	1.60 bu.	13/ton	21.50 t	5/AUM
Total income	$84.00	$91.20	$98.00	$195.00	$129.00	$37.50
Total net income	$-2.45	$26.69	$33.53	$ 62.93	$ 61.81	$ 1.53
less 10% mgt.		2.67	3.35	6.29	6.18	.15
Net income/acre	$-2.45	$24.02	$30.18	$56.64	$ 55.63	$ 1.38
Total income/crop	-47.75	324.27	90.54	736.32	333.78	23.46
Amount of water/acre	4.24	2.22	2.21	3.37	3.32	4.00
Acre feet of water/crop	82.68	29.83	6.63	43.80	19.90	68.00
Value/acre foot used/acre	-.57	10.86	13.65	16.80	16.75	.38

[a] Price of wheat and barley also includes straw at $18 per acre.

$$RV_f = \frac{1460.62}{250} = \$5.84$$

Table 20. Net income (NI) and residual value of water (RV_1) using 4 percent interest on investment for a 72-acre farm in Cache County

Acres:	19.5	13.5	3	13	6	17
Crops:	Alfalfa	Barley	Wheat	Beets	Corn	Pasture
Total expense	$73.26	$54.76	$54.72	$117.53	$57.61	$28.37
plus 4% interest	17.59	13.00	13.00	19.38	12.77	10.13
Total expense	89.85	67.76	67.72	136.91	70.38	38.50
Yield	4 ton	40 bu.	50 bu.	15 ton	6 ton	7.5 AUM
Price/unit[a]	21/ton	1.22 bu.	1.60 bu.	12/ton	21.50 t	5 AUM
Total income	$84.00	$91.20	$98.00	$195.00	$129.00	$37.50
Total net income	$-5.85	$23.44	$30.28	$ 58.09	$ 58.62	$-1.00
less 10% mgt.		2.34	3.02	5.81	5.86	
Net income/acre	$-5.85	$21.10	$27.26	$52.28	$ 52.76	$-1.00
Total income/crop	-114.07	284.85	81.78	679.65	316.56	-17.00
Amount of water/acre	4.24	2.21	2.21	3.37	3.32	4.00
Acre feet of water/crop	82.68	29.83	6.63	43.80	19.90	68.00
Value/acre foot used/acre	-1.38	9.54	12.33	15.51	15.89	-.25

[a] Price of wheat and barley also includes straw at $18 per acre.

$$RV_f = \frac{\$1231.76}{250} = \$4.92$$

Table 21. Net income (NI) and residual value of water (RV_1) using 5 percent interest on investment for a 72-acre farm in Cache County

Acres:	19.5	13.5	3	13	6	17
Crops:	Alfalfa	Barley	Wheat	Beets	Corn	Pasture
Total expense	$73.26	$54.76	$54.72	$117.53	$57.61	$28.37
plus 5% interest	21.98	16.25	16.25	24.27	15.96	12.66
Total expenses	95.24	71.01	70.97	141.80	73.57	41.03
Yield	4 ton	60 bu.	50 bu.	15 ton	6 ton	7.5 AUM
Price/unit[a]	21/ton	1.22 bu.	1.60 bu.	13 ton	21.50 t	5/AUM
Total income	$84.00	$91.20	$98.00	$195.00	$129.00	$37.50
Total net income	$-11.24	$20.19	$27.03	$53.20	$ 55.43	$-3.53
less 10% mgt.		2.01	2.70	5.32	5.54	
Net income/acre	$- 11.24	$18.18	$24.33	$47.88	$ 49.89	$-3.53
Total income/crop	$-219.18	$245.43	$72.99	$622.44	$299.34	$-60.01
Amount of water/acre	4.24	2.21	2.21	3.37	3.32	4.00
Acre feet of water/crop	82.68	29.83	6.63	43.80	19.90	68.00
Value/acre foot used/acre	-2.65	8.23	11.01	14.21	15.02	-.88

[a] Price of wheat and barley also includes straw at $18 per acre.

$$RV_f = \frac{\$961.00}{250} = \$3.84$$

Table 22. Net income (NI) and residual value of water (RV_f) using 7 percent interest on investment for a 72-acre farm in Cache County

Acres:	19.5	13.5	3	13	6	17
Crops:	Alfalfa	Barley	Wheat	Beets	Corn	Pasture
Total expense	$73.26	$54.76	$54.72	$117.53	$57.61	$28.37
plus 7% interest	30.77	22.75	22.75	33.92	22.35	25.43
Total expense	104.03	77.51	77.47	151.45	79.96	53.80
Yield	4 ton	60 bu.	50 bu.	15 ton	6 ton	7.5 AUM
Price/unit[a]	21/ton	1.22 bu.	1.60 bu.	13/ton	21.50 t	5 AUM
Total income	$84.00	$91.20	$98.00	$195.00	$129.00	$37.50
Total net income	$-20.03	$13.69	$20.53	$43.55	$ 49.04	$-16.30
less 10% mgt.		1.37	2.05	4.35	4.90	
Net income/acre	$-20.03	$12.32	$18.48	$39.10	$ 44.14	$-16.30
Total income/crop	-390.58	166.32	55.44	508.30	264.84	-277.10
Amount of water/acre	4.24	2.21	2.21	3.37	3.32	4.00
Acre feet of water/crop	82.68	29.83	6.63	43.80	19.90	68.00
Value/acre foot used/acre	-4.72	5.57	8.36	11.60	13.29	-4.07

[a] Price for wheat and barley also includes straw at $18 per acre.

$$RV_f = \frac{\$327.22}{250} = \$1.30$$

Table 23. Operating and fixed expenses of a 12h.5-acre farm in Cache County, Utah

Acres:	32	17	22	19	h	30.5	
Crops:	Alfalfa	Wheat	Barley	Beets	Peas	Pasture	Total for farm
Operating exp.							
Misc. labor	$ 2.10	$ 2.10	$ 2.10	$ 2.10	$ 2.10	$ 2.10	$ 261.h5
Labor	1h.h0	9.20	9.20	h8.10	1h.60	6.30	1,98h.05
Seed	.97	used own seed		3.50	22.00	1.56	233.20
Fertilizer	1.30			5.73		1.30	190.12
Spraying	.70		.88		1.50		h7.76
Twine	1.70		.80				72.00
Fuel & oil	h.55	3.61	3.59	7.hh	3.53	.81	h66.15
Truck & auto exp.	1.h9	1.h9	1.h9	1.h9	1.h9	.72	162.02
Harv.(custom)		6.00	6.00				23h.00
Misc. 2% exp.	1.3h	1.00	1.08	2.22	1.h1	.6h	150.98
Total operating expense	$28.55	$23.h0	$25.1h	$70.58	$h6.63	$13.h3	$3,801.73
Fixed exp.							
Taxes: land & equip.	h.58	3.7h	3.7h	h.81	3.7h	3.58	507.96
Insurance: Bldg. & equip.	.58	.58	.58	.58	.58	.58	72.21
Deprec.,repair on equip.	16.65	9.h7	9.h7	17.h6	8.h9	h.10	1,392.88
Deprec.,repair on bldgs.	.75	1.33	1.33	.75	1.33	.75	118.31
Utilities	.2h	.2h	.2h	.2h	.2h	.2h	29.88
Total fixed expenses	$22.80	$15.36	$15.36	$23.8h	$1h.38	$ 9.25	$2,121.2h
Total expenses (interest not incl.)	$51.35	$38.76	$h0.50	$9h.h2	$61.01	$22.68	$5,922.97
Total farm inv. per acre	$358.33	$323.00	$323.00	$371.66	$28h.33	$270.33	
Interest @ 3%	10.75	9.69	9.69	11.15	8.53	8.11	
h%	1h.33	12.92	12.92	1h.86	11.37	10.81	
5%	17.91	16.15	16.15	18.58	1h.21	13.51	
7%	25.08	22.61	22.61	26.01	19.90	18.92	

Table 2h. Net income (NI) and residual value of water (RV_1) using 3 percent interest on investment for a 12h.5-acre farm in Cache Valley

Acres:	32	17	22	19	h	30.5
Crops:	Alfalfa	Wheat	Barley	Beets	Peas	Pasture
Total expense	$51.35	$38.76	$h0.50	$9h.h2	$61.01	$22.68
plus 3% interest	10.75	9.69	9.69	11.15	8.53	8.11
Total expense	62.10	h8.h5	50.19	105.57	69.5h	30.79
Yield	h ton	50 bu.	60 bu.	15 ton	1.6 ton	7.5 AUM
Price/unit[a]	21/ton	1.60 bu.	1.22 bu.	13/ton	83.00 t	5 AUM
Total income	$8h.00	$98.00	$91.20	$195.00	$ 132.80	$37.50
Total net income	$21.90	$h9.55	$h1.01	$ 89.h3	$ 63.26	$ 6.71
less 10% mgt.	2.19	h.95	h.10	8.9h	6.32	.67
Net income/acre	19.71	hh.60	36.91	80.h9	56.9h	6.0h
Total income/crop	630.72	758.20	812.02	1529.31	227.76	18h.22
Amount of water/acre	h.2h	2.21	2.21	3.37	2.50	h.00
Acre feet of water/crop	135.68	37.57	h8.62	6h.03	10.00	122.00
Value/acre foot used/acre	h.6h	20.18	16.70	23.88	22.77	1.51

[a] Price of wheat and barley also includes straw at $18 per acre.

$$RV_f = \frac{\$h,1h2.23}{h18} = \$9.90$$

Table 25. Net income (NI) and residual value of water (RV_1) using 4 percent interest oninvestment for a 124.5-acre farm in Cache Valley

Acres:	32	17	22	19	4	30.5
Crops:	Alfalfa	Wheat	Barley	Beets	Peas	Pasture
Total expense	$51.35	$38.76	$40.50	$94.42	$61.01	$22.68
plus 4% interest	14.33	12.92	12.92	14.85	11.37	10.81
Total expense	65.68	51.68	53.42	109.28	72.38	33.49
Yield	4 ton	50 bu.	60 bu.	15 ton	1.6 t	7.5 AUM
Price/unit[a]	21/ton	1.60 bu.	1.22 bu.	13/ton	83.00 t	5 AUM
Total income	$84.00	$98.00	$91.20	$195.00	$132.80	$37.50
Total net income	$18.32	$46.32	$37.78	$ 85.72	$ 60.42	$ 4.01
less 10% mgt.	1.83	4.63	3.78	8.57	6.04	.40
Net income/acre	16.49	41.69	34.00	77.15	54.38	3.61
Total income/crop	527.68	708.73	748.00	1465.85	217.52	110.10
Amount of water/acre	4.24	2.21	2.21	3.37	2.50	4.00
Acre feet of water/crop	135.68	37.57	48.62	64.03	10.00	122.00
Value/acre foot used/acre	3.88	18.86	15.38	22.89	21.52	.90

[a]Price of wheat and barley also includes straw at $18 per acre.

$$RV_f = \frac{\$3,777.88}{418} = \$9.03$$

Table 26. Net income (NI) and residual value of water (RV_1) using 5 percent interest on investment for a 124.5-acre farm in Cache Valley

Acres:	32	17	22	19	4	30.5
Crops:	Alfalfa	Wheat	Barley	Beets	Peas	Pasture
Total expense	$51.35	$38.76	$40.50	$94.42	$61.01	$22.68
plus 5% interest	17.91	16.15	16.15	18.58	14.21	13.51
Total expense	69.26	54.91	56.65	113.00	75.22	36.19
Yield	4 ton	50 bu	60 bu.	15 ton	1.6 ton	7.5 AUM
Price/unit[a]	21/ton	1.60 bu.	1.22 bu.	13/ton	83.00 t	5 AUM
Total income	$84.00	$98.00	$91.20	$195.00	$132.80	$37.50
Total net income	$14.74	$43.09	$34.55	$ 82.00	$ 57.58	$ 1.31
less 10% mgt.	1.47	4.31	3.45	8.20	5.76	.13
Net income/acre	13.27	38.78	31.10	73.80	51.82	1.18
Total income/crop	424.64	659.26	684.20	1402.20	207.28	35.99
Amount of water/acre	4.24	2.21	2.21	3.37	2.50	4.00
Acre feet of water/crop	135.68	37.57	48.62	64.03	10.00	122.00
Value/acre foot used/acre	3.12	17.54	14.07	21.89	20.72	.29

[a] Price of wheat and barley also includes straw at $18 per acre.

$$RV_f = \frac{\$3,143.57}{418} = \$8.16$$

Table 27. Net income (NI) and residual value of water (RV_1) using 7 percent interest on investment for a 124.5-acre farm in Cache Valley

Acres:	32	17	22	19	4	30.5
Crops:	Alfalfa	Wheat	Barley	Beets	Peas	Pasture
Total expense	$51.35	$38.76	$40.50	$94.42	$61.01	$22.68
plus 7% interest	25.08	22.61	22.61	26.01	19.90	18.92
Total expense	76.43	61.47	63.11	120.41	80.91	41.60
Yield	4 ton	50 bu.	60 bu.	15 ton	1.6 ton	7.5 AUM
Price/unit[a]	21/ton	1.60 bu.	1.22 bu.	13/ton	83.00 t	5 AUM
Total income	$84.00	$98.00	$91.20	$195.00	$132.80	$37.50
Total net income	$ 7.57	$36.63	$28.09	$ 74.59	$ 51.89	$-4.10
less 10% mgt.	.75	3.66	2.81	7.46	5.19	
Net income/acre	6.82	32.97	25.28	67.13	46.70	-4.10
Total income/crop	218.24	560.49	556.16	1275.47	186.80	-125.05
Amount of water/acre	4.24	2.21	2.21	3.37	2.50	4.00
Acre feet of water/crop	135.68	37.57	48.62	64.03	10.00	122.00
Value/acre foot used/acre	1.60	14.91	11.43	19.91	18.68	-1.02

[a] Price of wheat and barley also includes straw at $18 per acre.

$$RV_f = \frac{\$2,672.11}{418} = \$6.39$$

AGREEMENT

THIS AGREEMENT, Made this 26th day of June, 1963, between the LOGAN, HYDE PARK AND SMITHFIELD CANAL COMPANY, THE LOGAN NORTHERN IRRIGATION COMPANY, THE LOGAN HOLLOW IRRIGATION COMPANY, THE PROVIDENCE-LOGAN IRRIGATION COMPANY, THE LOGAN ISLAND IRRIGATION COMPANY, THE SEVENTH WARD IRRIGATION COMPANY, THE THATCHER ASSOCIATION, THE LOGAN NORTHWEST IRRIGATION COMPANY, THE SOUTHWEST FIELD IRRIGATION COMPANY, THE PROVIDENCE PIONEER IRRIGATION COMPANY, THE HYDE PARK IRRIGATION COMPANY, THE LOGAN NORTH FIELD IRRIGATION COMPANY, THE BENSON IRRIGATION COMPANY and THE CENTRAL MILLING COMPANY, all of which shall hereinafter be called the COMPANIES, and LOGAN CITY, a Municipal Corporation, who shall hereinafter be referred to as the CITY.

WITNESSETH:

WHEREAS, All of the parties to this Agreement are owners of primary water rights in the Logan River as set out in Schedule A in the Decree of the District Court of Cache County, dated September 21, 1922, in the case of Utah Power & Light Company, Plaintiff, vs. Richmond Irrigation Company, et al., Defendants, which decree is commonly known as the Kimball Decree; and

WHEREAS, The District Court of the First Judicial District in and for Cache County has recently decided a case between the parties hereto which determined that said Schedule A shall be modified to provide that Logan City is entitled to 10 second feet of water from DeWitt Spring in Logan Canyon throughout the year and without regard to the flow of Logan River; and

WHEREAS, No Decree has been entered in said case but its entry has been temporarily suspended by agreement of the parties pending the negotiation of an agreement of settlement between the parties; and

WHEREAS, Logan City is the owner of diverting works and a 20.0 second foot capacity pipeline which conveys water from DeWitt Spring to Logan City, and it is practicable and economical for Logan City to divert through said pipeline more than 10 second feet of water for municipal purposes; and

WHEREAS, Logan City is the owner of three producing wells and is in the process of developing a fourth well, all of which are so located that water can be diverted from them into some of the canals of the Companies;

NOW, THEREFORE, The parties agree as follows:

1. Upon the execution of this Agreement, the parties shall forthwith request the District Court to enter a Decree in the case of Logan City, a Municipal Corporation, Plaintiff vs. Logan, Hyde Park and

Smithfield Canal Company, et al., Defendants, in a form which is attached hereto and made a part hereof. No party will take an appeal from said Decree to the Supreme Court of Utah, nor will any party in any other manner contest or challenge such Decree.

2. The City will file in the State Engineer's Office an exchange application to enable it to take water during the irrigation season from April 1st to September 30th of each year from DeWitt Spring in excess of its direct flow rights. Such exchange application shall provide that well water will be delivered to the Companies in exchange for such excess water so taken from DeWitt Spring. The Companies will not oppose the City's application to the State Engineer, and if requested to do so, will, by letter or other appropriate method, request the approval of such application.

3. The exchange contemplated by this Agreement shall not require the simultaneous dischange of water from the City wells into the canals of the Companies but shall require the discharge of 1 acre-foot of water into such canals for every acre-foot of water diverted by Logan City from DeWitt Spring at some time during the same irrigation season in which the water is so diverted. The period of diversion and the flow diverted at DeWitt Spring shall be determined exclusively by the City, and the period of diversion and flow of water to be discharged from the City wells into the Companies' canals shall be determined exclusively by the Companies; provided, however, that the diversion from the wells shall be limited to the flow of water produced thereby in excess of the flow reserved to and used by the City. Requests for delivery of water from City wells and requests for shutoff shall be in writing and filed in duplicate with the City Engineer. Annually, on the 1st day of November of each year, there shall be an accounting between the City and the Companies to determine the quantity of water so diverted from DeWitt Spring and the City wells. After offsetting such diversions, either party shall pay the other for excess water diverted during the preceding year at the rate of $4.00 per acre-foot. Payments shall be made within sixty (60) days after said date. This rate is established solely for the purpose of this Agreement. The water rate shall be reviewed and renegotiated by the parties three years from date hereof.

4. The City agrees to maintain at its expense automatic measuring devices at DeWitt Spring and each City well used for water exchange at all times while this contract is in effect. Such measuring devices shall be approved by the State Engineer and shall, at all reasonable times, be made available for inspection by the LoganRiver Water Commissioner. The cost of operating and maintaining pumps on the City wells to effectuate the exchange shall be paid by the City.

5. The City shall make a separate agreement with the Utah Power & Light Company so that the Companies shall be protected from and held harmless against any claim by the Utah Power & Light Company for damages which might result from the exchange herein provided.

6. The Companies will not protest any application filed by the City for appropriation of additional water from DeWitt Spring or Logan

River during the non-irrigation season or during the high water period within the irrigation season provided that any such application shall be subject to the prior rights of the Companies.

7. Nothing contained herein shall be construed to affect the City's water rights evidenced by water stock, or the right of the City to effect water exchanges.

IN WITNESS WHEREOF, The Parties hereto have hereunto set their hands the day and year first above written.

LOGAN, HYDE PARK AND SMITHFIELD CANAL COMPANY
By Keith Meikle, President

LOGAN NORTHERN IRRIGATION COMPANY
By J. G. Plowman, President

LOGAN HOLLOW IRRIGATION COMPANY
By Alma W. Zbinden, President

PROVIDENCE LOGAN IRRIGATION COMPANY
By Heber L. Olson, President

LOGAN ISLAND IRRIGATION COMPANY
By Morris T. Hodges, President

SEVENTH WARD IRRIGATION COMPANY
By Russell V. Anderson, President

LOGAN NORTHWEST IRRIGATION COMPANY
By J. W. Quayle, President

SOUTHWEST FIELD IRRIGATION COMPANY
By Owen Jenson, President

PROVIDENCE PIONEER IRRIGATION COMPANY
By Mahlon F. Rice, President

HYDE PARK IRRIGATION COMPANY
By Niles Follett, President

LOGAN NORTH FIELD IRRIGATION COMPANY
By Alfred H. Gnehm, President

BENSON IRRIGATION COMPANY
By Parley A. Reese, President

LOGAN CITY
By Theral V. Bishop, Mayor

VITA

Marlyn Lee Fife

Candidate for the Degree of

Master of Science

Thesis: Irrigation Water Values in Cache County, Utah

Major Field: Agricultural Economics

Biographical Information:

Personal Data: Born at Idaho Falls, Idaho, November 22, 1928, son of Robert Lee and Zenobia S. Fife; married Eliza Rose Ruf July 9, 1952; seven children--Ragena, Shawna, Renita, Walter, Tamara, Vanya, and James.

Education: Attended elementary and high school in Ammon, Idaho; graduated in 1947; attended Brigham Young University in 1947 and 1948; received Bachelor of Science from Utah State University with a degree in Agricultural Economics, 1953; completed requirements for the Master of Science degree in Agricultural Economics at Utah State University in 1967.

Professional Experience: June 1967 to present, Regional Farm Economist for the provincial government of Alberta, Canada; 1961-1965, chairman of Ammon Farm Bureau; 1955-1965, owned and operated a fifty cow, Grade A dairy and a three hundred and twenty acre irrigated farm in Idaho Falls, Idaho; 1953-1955, training officer in the United States Army at Fort Lee, Virginia.